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People and the Sound

FISH AND WILDLIFE

A Planning Report prepared for the New England River Basins Commission by the U.S. Department of the Interior, Fish and Wildlife Service; and the U.S. Department of Commerce, National Marine Fisheries Service

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New England River Basins Commission

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The Long Island Sound Regional Study is a "level B water and related land resources study." It was conducted under provisions of the federal Water Resources Planning Act of 1965. The Plan which has been developed was prepared by a team of federal, state, and regional officials, local citizens, and the scientific community, under the overall coordination of the New England River Basins Commission. It is a part of the Commission's comprehensive, coordinated joint plan for the water and related land resources of its region, which includes New England and the New York portions of Long Island Sound.

The plan for Long Island Sound recommends a program for action by federal, state, and local governments; it does not bind them to undertake specific recommended actions. To assist in the evaluation and implementation process, the following reports have been prepared.

A PLAN FOR LONG ISLAND SOUND: A SUMMARY. Highlights of the plan and a brief discussion of the rationale leading to recommendations.

A PLAN FOR LONG ISLAND SOUND: SUPPLEMENT. A more comprehensive planning document which enumerates the major alternatives considered in formulating the recommendations, together with an explanation of how the plan was prepared, who did the work, and background information organized both by subject matter and by geographical sub-regions of the Study Area.

PLANNING REPORTS. Each planning report was developed by a "Work Group," chaired by a federal agency, with the active participation of state and local agencies, other federal agencies and citizen and scientific advisors. These reports incorporate data (originally published in a series of Interim Reports) which estimate people's demands for the resources of the Sound region, the requirements needed to meet those demands, the existing capacity of the region to meet the requirements, and any deficiencies noted.

The second half of each planning report develops solutions by stating objectives in terms of satisfying defined needs, suggesting alternative ways to achieve the objective, evaluating each alternative in terms of environmental, economic, and social criteria, developing economic, environmental, and composite plans, and finally making recommendations.

The following Planning Reports were prepared:

Water Management by the U. S. Environmental Protection Agency, and the States of New York and Connecticut.

Land Use by Ralph M. Field and Associates for the U. S. Department of Housing and Urban Development.

Outdoor Recreation by the U. S. Department of the Interior, Bureau of Outdoor Recreation.

Fish and Wildlife by the U. S. Department of the Interior, Fish and Wildlife Service; and the U. S. Department of Commerce, National Marine Fisheries Service.

Shoreline Appearance and Design by the U. S. Department of the Interior, National Park Service and Roy Mann and Associates.

Marine Transportation by the U. S. Department of the Army, Corps of Engineers.

Power and the Environment by Federal Power Commission staff.

Mineral Resources and Mining by the U. S. Department of the Interior, Bureau of Mines.

Flood Damage Reduction by the U. S. Department of the Army, Corps of Engineers, and the U. S. Department of Agriculture, Soil Conservation Service.

Erosion and Sedimentation by the U. S. Department of the Army, Corps of Engineers; and the U. S. Department of Agriculture, Soil Conservation Service.

OTHER REPORTS published in conjunction with the Study are:

An Economic Perspective by the U. S. Department of Agriculture, Economic Research Service; and the U. S. Department of Commerce, Bureau of Economic Analysis. An examination of the economic and demographic trends in the region, with data for use as the basis of all projections made in the Study.

Shoreline Appearance and Design: A Planning Handbook by Roy Mann Associates, Inc., for the U. S. Department of the Interior, National Park Service. Recommended management procedures for protecting and enhancing the region's scenic resources.

Sources and Movement of Water by the U. S. Geological Survey, Water Resources Division; and the National Oceanic and Atmospheric Administration. A summary of the hydrology and climate of the region.

Soils by the U. S. Department of Agriculture, Soil Conservation Service. An inventory and analysis of soil composition in the region.

For a complete listing of reports published by or in conjunction with the Study, see Appendix A of the Supplement. Copies of these reports are available from:

New England River Basins Commission
55 Court Street
Boston, Mass. 02108

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FISH AND WILDLIFE

A Planning Report

Long Island Sound Regional Study
New England River Basins Commission
270 Orange Street
New Haven, Connecticut 06511

A Summary of
Reports Prepared by the

U. S. Fish & Wildlife Service
U. S. Department of the Interior

National Marine Fisheries Service
U. S. Department of Commerce

February, 1975

FOREWORD

Long Island Sound is one of the nation's unique and irreplaceable natural resources. An almost fully enclosed arm of the ocean, it has over 1300 square miles of water surface and over 600 miles of coastline. Spreading eastward along both shores from the great metropolitan center which lies at the Sound's western end, a growing concentration of increasingly affluent people make ever greater demands on this urban sea. At the same time, there is a growing feeling that the conflicting demands are destroying the Sound, and that the problems must be resolved if the Sound is to be preserved.

The Long Island Sound Regional Study is a comprehensive planning effort by the Federal government and New York and Connecticut, led by the New England River Basins Commission. Assisting the Commission are professionals from many disciplines representing the Federal, state and regional agencies listed on the back cover, a Citizen Advisory Committee, and a Research/ Planning Advisory Committee composed of members of the region's scientific community.

> THE GOAL OF THE STUDY IS TO PRODUCE A PLAN OF ACTION BY THE SPRING OF 1975 WHICH BALANCES THE NEEDS TO PROTECT, CONSERVE AND WISELY DEVELOP THE SOUND AND ITS RELATED SHORELANDS AS A MAJOR ECONOMIC AND LIFE-ENRICHING RESOURCE FOR THE 12 MILLION PEOPLE WHO LIVE NEAR IT.

This planning report is one of a series. The first half of each report is problem-oriented. It summarizes demands placed upon the Sound and adjacent lands, their capacity to supply these demands, and present or expected needs to be met, if it is determined that supply should meet demand. The last half of each report is solution-oriented. It formulates tentative objectives and alternative measures for achieving the objectives. It evaluates the environmental, economic and social implications of each measure and formulates alternative plans. One plan is tentatively recommended. The planning reports are printed and distributed before the final version of main report. Therefore, final recommendations are to be found only in the main report, scheduled for publication in the Spring of 1975. Planning reports in this series include:

Land Use	Recreation
Water Management	Fish and Wildlife
Shoreline Appearance & Design	Marine Transportation
Erosion and Sedimentation	Minerals
Flood Damage Reduction	Power and the Environment

SUMMARY

PURPOSE OF THIS REPORT. To assemble information on the ecosystem of the Long Island Sound (LIS) Region, its fishery, and its wildlife and to recommend measures for uses of these resources that will be compatible on an environmental, economic, and social basis.

THE ECOSYSTEM

Long Island Sound is an integrated system of biological communities and certain physical and chemical conditions and resources. Estuarine conditions are a dominating feature of the Sound waters. Wetlands are particularly important to the estuarine system because they provide habitat and food, and they serve as pollution filters and heavy metal sinks. The Sound is 80 feet deep, on the average, with light penentration reaching to approximately 30 feet. The circulation pattern of the Sound is complex with only moderate mixing of the denser salt water and incoming fresh water. This circulation pattern, however, is sufficient to bring nutrients from the bottom waters to the surface layers where they can be utilized by the phytoplankton and zooplankton populations in the Sound. Primary productivity and standing crop (phytoplankton) are high in the Sound, but productivity drops at the herbivore (plant-eating zooplankton) level and is less efficient at the carnivore (animal-eating) level.

THE FISHERY

Present annual consumption of fishery products in the LIS region is 96 million pounds. However, the Sound supplies only a small percent of this demand. Commercial landings of finfish have declined to almost one-sixth the 17 million pounds landed in 1956, although the total landed value has remained relatively constant at between $2-3 million. It must be stated, however, that because of dollar devaluation this dockside value is worth less today than it was in 1956. The landings of all significant shellfish species have also declined, including the lobster fishery which has decreased steadily since 1969. LIS saltwater anglers in 1970 numbered approximately 818,000, each averaging over 12 days of fishing. The estimated annual yield of sport fish as well as sport fishing demand have been difficult to assess. The comparison of sportfishing and commercial fishing on an economic basis is also difficult, since their values are not based on comparable costs. It is estimated that sportfishing is probably more "valuable" than commercial fishing in terms of total economic return, but until accurate data for the sport and commercial fishery are obtained, no valid comparison of these fisheries can be made. In view of these facts, a conservative fishery management policy is recommended for the present time. It would appear that the major limitations to productivity of the fishery are loss of habitat and deterioration of water quality. Fortunately, due to recently enacted wetland legislation in New York and Connecticut, the present wetland loss rate appears to be stabilizing near zero. Water quality, however, continues to be a major problem. The Sound waters west of Oyster Bay and Stamford plus many Connecticut estuaries with marginal water quality remain closed to shellfish harvesting due to pollution.

THE WILDLIFE

To the LIS populace the value of the Sound's wildlife is primarily aesthetic. Birdwatching, nature walks, and nature photography are popular pastimes. Hunting is not a major activity within the LIS region although waterfowl populations in the Long Island area have shown great increases over the last ten years. A total of approximately 16,000 hunters hunted within the LIS area in 1970 primarily for small game (cottontail, pheasant, and squirrel) and waterfowl (mallard, black duck, teal, and scaup). Yet, this number of hunters represents only a small portion of the LIS population when compared to the numbers engaged in "non-consumptive" activities such as hiking and birdwatching.

FISH AND WILDLIFE

OBJECTIVE AND ALTERNATIVE MEASURES

Two objectives are considered: (1) sustain the natural biological productivity of the Sound's ecosystem, including the Sound's shoreland and upland wildlife resources, and (2) increase the economic value and enjoyment of the Sound's marine resources. Fourteen alternative measures were considered relating either to the satisfaction of the demand for the Sound's fishery and wildlife resources or to the enhancement of the productivity of these resources.

EVALUATION

Alternative measures were evaluated in terms of environmental, economic, and social criteria. Environmental concepts include (1) preservation, creation, and/or restoration of wetlands and islands, (2) emphasis on the value and wise utilization of the Sound's finfish, shellfish, and wildlife species, (3) improvement of fishery and wildlife habitat, and (4) maintenance of or increases in species diversity. Economic concepts include consideration of (1) total benefits, (2) total costs, (3) benefit/cost ratios, and (4) the contribution of recommended measures to economic stability. Social concepts consider methods of improving access to and use of the Sound's fishery and wildlife resources. Of the 14 measures, the potentially most effective ones are those dealing with wetland and island preservation, fishery management/research programs, improvement of water quality, establishment of fishing piers, and establishment of environmental education programs.

ALTERNATIVE PLANS

Three plans were formulated: environmental quality (EQ), national economic development (NED), and a composite of the two plans.

RECOMMENDATION

The Composite Plan is recommended since it eliminates those measures which rated only fairly on an environmental, economic, and social basis. Of the remaining measures, those measures which rated "Good" on an environmental and social basis are strongly recommended. Among these are establishment of fishery management/research programs, improvement of water quality, restoration and creation of wetland areas, promotion of underutilized finfish and shellfish, improvement of fishery habitat, expansion of wildlife management areas, and establishment of environmental education programs.

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1.0 THE PURPOSE OF THIS REPORT

The purpose of this planning report is to assemble information on the ecosystem of the Long Island Sound (LIS) Region, its fishery, and its wildlife and to recommend measures for uses of these resources that will be compatible on an environmental, economic, and social basis.

To accomplish its purpose, the first half of this planning report --

- Examines the LIS ecosystem -- how it functions, its relationship to wetlands, how productive it is, and what limits its productivity.

- Examines the LIS fishery, both commercial and sport, the demands placed upon it, its present condition and capacity, and limitations on its growth.

- Examines LIS wildlife, its current status and limitations on its growth, and its importance both in terms of values associated with the aesthetic quality of life and in terms of hunting.

The second half of the planning report is solution-oriented. It --

- Formulates objectives.

- Identifies alternative measures for achieving the objectives.

- Evaluates the alternatives environmentally, economically, and socially.

- Formulates three alternative plans -- stressing environmental quality, national economic efficiency, and a composite of each, and

- Recommends a plan and adjusts it to accommodate multi-purpose considerations and public input.

1.1 INTRODUCTION

The fish and wildlife resources in the Long Island Sound region consist of a wide variety of Atlantic faunal and floral species and natural and modified habitats. While we recognize the effects of development in the

area, our primary objectives are to evaluate the basic ecological system of the Sound region, and to consider both the development-related and the natural alterations in this system. Certainly man's knowledge of ecological systems has increased and will continue to increase, although we appear to face an environmental predicament in that the capacity to alter these systems may increasingly exceed our capacity to foresee environmental consequences. Thus, even with adequate knowledge, our ability to foresee and adequately evaluate and compensate for environmental change becomes increasingly difficult. Therefore, we have taken, as a major response to planning, both for the present and as a baseline for the future, a review of conditions resulting in environmental change and their application to the study area.

In identifying combined actions and possible outcomes of those actions which consistently cause and sustain significant environmental changes, we recognize that the present social system defines, to some degree, the environmental conditions most likely to persist. Similarly, the projection method used in the development of plans and recommendations tends to accept the social state as it exists, and to some degree makes future changes more difficult. This is not to say that projections are not useful, but in this report we have not taken projections or social structure as dominating constraints, so that more desirable environmental outcomes could be considered, recommended, and perhaps obtained.

In presenting the fish and wildlife planning report, we have included to some degree the following ecosystem and planning concepts. First of all, a major requirement is the avoidance of conditions or sets of actions which lead to domination or reduce variety or diversity. Dominating factors, particularly if rapidly developed, are significant in their ecosystem-damaging potential. Secondly, and in direct relation to the first, our evaluations discourage actions which are likely to lead to large-scale irreversible ecological change. Third, we place a high value on environmental diversity, including a wide variety of essentially untouched ecosystem components, as well as managed and developed ones. Finally, the concepts of ecosystem organization, including directional and potential states, capacity, succession, specialization, and evolution, are included as integral parts of our planning efforts for the preservation, protection, and management of the fish and wildlife resources of the Long Island Sound region. It is through these evaluations that the Fish and Wildlife Planning Report is formed and presented.

Before considering a possible management plan for the Sound, it is necessary to first consider the Sound's present environmental system and the demands placed upon that system. The following section examines the Sound's ecosystem (productivity), its fishery, and its wildlife resources. The demands, requirements, and needs of the public in relation to use of these resources is also examined. The remaining sections of the planning report consider what methods can be used to satisfy the latter demands on the Sound's resources, while at the same time, maintaining or improving the Sound's environmental conditions.

2.0 THE ECOSYSTEM

2.1 How does the LIS ecosystem function?

Long Island Sound is an estuary -- a semi-enclosed coastal body of water with a free connection to the open sea and within which sea water is measurably diluted with fresh water derived from land drainage. Long Island Sound is a unique estuary in that it is open at both ends and subject to an unusual source of fresh water input; most of the Sound's freshwater enters from the eastern Connecticut rivers near the oceanic end of the Sound.

Physically, the Sound is 113 miles long and 21 miles wide at its widest point. It is fairly deep in comparison to other east coast estuaries, averaging about 80 feet with depths up to 320 feet. Light rarely penetrates below 30 feet, as opposed to 600 feet in the open oceans. Very little fresh water enters the Sound from the Long Island side because of the small surface drainage area and the generally southward flow of the island's ground water. Most fresh water input, therefore, is from the mainland side, especially from the Connecticut River. Salt water enters the Sound through tidal action at its eastern and western ends, mostly at the former.

Within the Sound, the circulation pattern is considerably influenced by this tidal action and by the Sound's lateral boundaries. Other factors such as land drainage, meterological effects, and wind currents also influence the circulation pattern. Water temperature varies between 32°F and 90°F and salinity varies between 23°/00 and 31°/00 (parts per thousand), except at river mouths where it is less. The Sound has been classified as a moderately-stratified estuary in that ocean waters and fresh water do not mix completely. The dense marine waters remain unmixed below the surface over a large area of the eastern Sound. The lighter fresh water enters mostly in the eastern end from the Connecticut rivers, remains near the surface, and is flushed out to sea rather rapidly. However, sampling by the Connecticut Dept. of Environmental Protection, Region V, demonstrated that the low salinity wedge emerging at the Connecticut River estuary is rapidly mixed and cannot be detected far offshore.

It is believed that in the eastern part of the Sound the water tends to flush out to sea the lighter suspended pollutants from inland sources and brings up nutrient-rich waters from the bottom. This upwelling of richer water at deeper levels contributes to high nutrient levels (1).[1]
(A more complete description of circulation patterns in the Sound is published in another interim report, Sources and Movements of Water.)

Biologically, Long Island Sound, like all estuaries, is a region of transition. To survive and successfully reproduce in an estuary an organism must be adaptable to a wider range of environmental fluctuations than those encountered in a strictly marine or fresh water environment. A wide combination of factors determines the distribution of estuarine organisms. This extreme

[1]Underlined numerals in parentheses are references in Appendix A.

cyclic variation of environmental factors is a permanent feature of the estuarine environment. The organisms that have become adapted to this environment must tolerate the extremes and may even require them.

Typical of estuaries, the marine fauna and flora of the Sound display a greater density of individuals but fewer species than are found in the open sea. The concentration of non-living particulate organic matter in the Sound is generally greater than the concentration of living phytoplankton[2], thus limiting light penetration as indicated earlier. The lack of sunlight may limit algal growth below 30 feet, but surface growth is rapid because there is enough tidal mixing to regenerate nutrients from the bottom waters.

2.2 How productive is the ecosystem?

The basic or primary productivity of an ecological system is the rate at which energy is stored by producer (photosynthetic) organisms in the form of organic substances which can be used as food materials. Net production is the rate of storage of the organic substances in plant tissues in excess of respiration. Secondary production is the rate of use and storage of the food materials already produced. Productivity is measured as a rate and is generally expressed in milligrams or grams of carbon produced per square meter per day (gm C/M^2/day). Productivity should not be confused with standing crop which is the biomass per unit area at any one time. Standing crop is a common measure of plant and animal abundance, and in terms of marine productivity, it is generally expressed as grams of carbon per square meter (gm C/M^2).

In Long Island Sound, the mean rate of photosynthesis is estimated at 1,300 mg C/M^2/day (2). This input produces a net production rate of 530 mg C/M^2/day at the primary level, dropping to ranges of 27 to 36 mg C/M^2/day at the herbivore (plant-eating) level and to 0.5 mg C/M^2/day at the carnivore (animal-eating) level. The standing crop in the Sound is estimated at 8 gm C/M^2 at the primary level, between 1 and 5 gm C/M^2 at the herbivore level, and only 0.2 gm C/M^2 at the carnivore level. Table 1 shows how these figures compare with other types of production. Neither lobster nor migratory pelagic (near-surface oceanic) finfish are included in these approximations.

Several key points can be made about productivity in the Sound:

(1) At the primary trophic level (photosynthesis), the Sound is highly productive. It compares favorably with the most productive of marine areas, the salt marsh. Primary productivity is related principally to changes in light and temperature. Therefore, most primary production in the Sound occurs in the upper 30 feet. About 200 species of phytoplankton have been

[2] Selected technical terms are defined in Appendix B.

TABLE 1. MEAN ANNUAL STANDING CROP AND MEAN DAILY PRODUCTION

Trophic level	Production mg C/M^2/day	Standing Crop gm C/M^2
Primary producers		
Phytoplankton, LIS	530	8
Phytoplankton, Ocean	250 (avg)	
Spartina salt marsh (growing season)	810	
Nova Scotia seaweed beds	180	
Grasslands, moist forests, shallow lakes	540	
Herbivores		
Zooplankton, LIS	27	1
Benthic invertebrates, LIS	36	5
Carnivores		
Benthic finfish, LIS	0.5	0.2
Intensive fish culture		35
World marine fishery	0.01	

recorded for Long Island Sound, and most of them are coastal temperate species as opposed to oceanic species or warm-water species. Diatoms and dinoflagellates are the most abundant floral forms in the Sound. The dominant diatoms are Skeletonema costatum, Thalassiosira nordenskioeldii, and Thalassionema nitzschioides. The dominant dinoflagellates are Peridinium trochoideum, Prorocentrum triestinum, and Prorocentrum scutellum (3). A very large population of microflagellates, Chlorella-like organisms, are also extremely abundant in the Sound. Most of the major phytoplankton organisms common to the Sound are also common to New England waters, and Skeletonema, which is most important in the Sound, is also important in other North Atlantic coastal waters. Four species have been identified as more characteristic of Long Island Sound: Schroederella delicatula, a diatom, and the dinoflagallates Exuviaella apora, Goniaulax minima, and Prorocentrum triestinum.

(2) At the herbivore level, secondary production and standing crop drop more rapidly than is typical of most estuarine areas, but are still fairly high. Utilization of the high primary production capacity of the Sound by the zooplankton that are present is somewhat inefficient (4). While the zooplankton are abundant and productive, their diversity is lower than in most other estuaries of North Atlantic coastal waters. The most common zooplanton in the Sound are the copepods, particularly the Acartia sp. It appears that the most abundant zooplankton organisms are not as efficient in their feeding, and may consume only about one-quarter of the primary production available to them. Zooplankton organisms are in direct competition with benthic filter feeders and, to a certain degree, detrital feeders. The water column also contains a high level

of bacteria and ultraplankton, and consumption by these forms may be even greater than that of the zooplankton. Some of the ultraplankton and nannoplankton organisms may be unavailable to the filtering apparatus of the most common zooplankton organisms in the Sound. Also, the more efficient and valuable marine zooplankton such as Calanus finmarchicus and Centropages typicus are generally excluded from the Sound, except at the extreme eastern end.

(3) Little is known of the relationship between the Sound's primary production and production at the carnivore level. It is believed that both production and standing crop drop rapidly. Numerically, the fauna of the Sound bottom are dominated by the microbenthos. These include bacteria, protozoans, nematodes, and other small organisms. These small organisms tend to be efficient in their growth, and are of direct value to blackfish, scup, sea robins, and flounder as food organisms. Molluscan shellfish, which are common on muddy bottoms, are similarly of value to finfish such as scup and flounder and are also important to waterfowl in their feeding areas. The Sound bottom also has ideal conditions for shellfish growth and for the growth of a number of worms and suspension and/or deposit-feeding invertebrate animals which are available to other carnivores as food.

Looking at the Sound as a dynamic trophic system rather than a static one, it is necessary to consider its nutrient reserves, their origin and input. Phosphate and nitrate, for example, are necessary for rapid phytoplankton growth, and small amounts may be enough to stimulate rapid production. The Sound system being estuarine is believed to be a very fertile and productive area due to the important fact that sea water already contains a considerable balance of fertilizing elements essential for phytoplankton growth. Also, the Sound being an area of fresh water inflow, particularly along the Connecticut shore, receives a measurable nutrient input from the human environment.

2.3 What is the role of wetlands?

Wetlands contribute to the overall functioning of the ecosystem in many ways -- as habitat, as detrital contributors to the food chain, as pollution filters, as sediment traps, and as heavy metal sinks.

Wetlands provide the principal habitat for wildlife and for many of the marine animal species of the Sound during certain stages of their life cycles. Wetlands are important as spawning areas, as nursery areas for juvenile stages, and as feeding areas for adult species. Perhaps the most important relationship of the wetlands to the ecosystem is their role in the food chain. Wetlands support the primary producers which, in turn, support a variety

of higher forms. The pathways of any food web illustrate the complex interrelationship of all organisms to the environment and the fine balance that is necessary to sustain life (Figure 1). Wetlands perform a valuable function in pollution filtration by oxidizing organic waste and by serving as nutrient "sinks", thus reducing the pollution load entering the Sound and the resulting algal blooms and eutrophication. They also act as "sediment traps" for materials otherwise deposited in channels. However, in erosion-prone parts of bays and along channels, wetlands can work in the opposite direction; if not vegetated, they can become a source of sediment.

Wetlands also act as heavy metal sinks. When heavy metals are introduced into a salt marsh situation, chelation (combining with sulfides or organic molecules) may occur, followed by precipitation of the newly-formed compounds. This reduces the load in the water column, but provides the aquatic plants with these substances as a substrate. Several heavy metals can have a deleterious effect on organisms in the estuarine environment: silver, arsenic, cadmium, chromium, copper, nickel, mercury, and zinc (Table 2).

TABLE 2. CHARACTERISTICS OF COMMON METALS OF CONCERN IN THE ESTUARINE ENVIRONMENT[1]

Metal	Natural concentration in sea water (mg/l)	Range of concentrations found in marine organisms		Minimum concentrations that have toxic effects on marine life (mg/l)
		Plants (mg/l)	Animals (mg/l)	
Silver	0.0003	0.25	1 to 3	Highly toxic
Arsenic	.003	30.0	0.0005 to 0.3	2.0
Cadmium	.08	.4	0.15 to 3	0.01 to 10.
Chromium	.00005	1.0	0.2 to 1.0	1.0
Copper	.003	11.0	4 to 50	0.1
Mercury	.00003	0.3	0.2 to 1.0[2]	0.1
Lead	.00003	8.4	0.5	0.1
Nickel	.0054	3.0	0.4	0.1
Zinc	0.1	150.0	6 to 1,500	10.0

[1]National Estuarine Pollution Study, 1970.

[2]Alexander, J.E., J. Foehrenbach, S. Fisher, and D. Sullivan. 1973. Mercury in striped bass and bluefish. N.Y. Fish & Game Journal. 20(2):147-151.

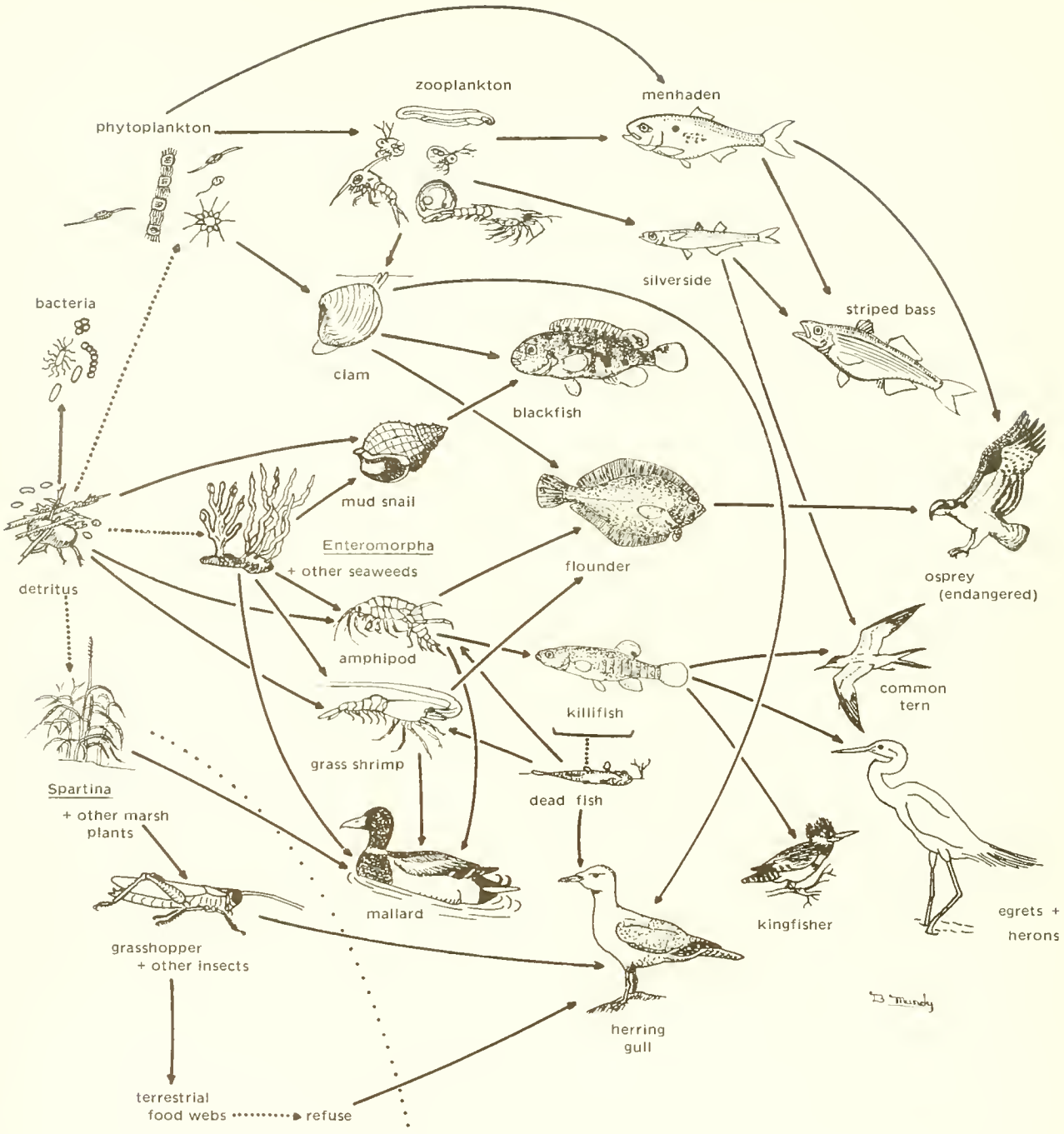


Figure 1. Illustrative food web pathways in a wetlands environment.

These metals are important as trace elements in the nutrient cycle of the marsh's primary producers, but they become harmful in excessive amounts. When introduced as salts, they are fairly soluble and stable in solution. Consequently, they are rather persistent. The toxic heavy metal concentrations listed in Table 2 represent the lowest values for the particular species tested and not absolute minimums. Also, these toxic levels do not consider the synergistic effect that may occur with the presence of other metals. For example, the toxic effects of mercuric salts are accentuated by the presence of trace amounts of copper. The table does indicate, however, the minute quantities of metal salts that can damage an estuarine system.

Although this report is focusing on the biological aspects of the Sound, it is worth stressing that wetlands contribute to many other aspects of the Sound, such as water quality, recreation, visual aesthetics, and flood protection. For example, wetlands indeed serve as a natural buffer for storm tides and waves. Marsh peat and vegetation are resilient and tend to intercept storm tides and absorb much of the energy of wave shocks. When wetlands are filled, this buffering action and the related flood storage capacity of the wetlands are lost.

The 1969 Session of the Connecticut General Assembly enacted legislation to define and bring under regulation the use of Connecticut's tidal wetlands. The legislation became effective October 1, 1969, and a tidal wetlands program was established by the Connecticut Department of Environmental Protection, Water and Related Resources Unit. Since 1969, 96 percent of Connecticut's wetlands have been defined. The emphasis of the program is now shifting the uses of wetlands so that further environmental degradation is prevented.

In September, 1973, New York's Tidal Wetlands Act became effective as an amendment to the environmental conservation law which gave protection and preservation to the tidal wetlands. The amendment was added to provide for an inventory of the wetlands and to develop a coastal zone management plan("land use regulations"). The inventory is to be conducted by the New York State Department of Environmental Conservation, and until the inventory and the coastal zone management plan are completed, a moratorium has been placed on all alteration of tidal wetlands in New York. However, during this moratorium, the New York State Department of Environmental Conservation may issue permits regarding the alteration of these wetlands provided such alteration will not have a detrimental effect upon the tidal wetlands.

3.0 THE FISHERY

3.1 How is the fishery important to the public?

Commercial fishing. Present annual consumption of fishery products in the study area is estimated at 96 million pounds.[3] By 1990, this demand is

[3]This figure is based on a regional fishery products consumption figure of 16 lbs/person as estimated by the National Marine Fisheries Service multiplied by a regional population figure of approximately six million persons as estimated by OBERS projections.

projected to 129 million pounds, and, by 2020, to 163 million pounds. Long Island Sound supplied only a small percent of the 1974 demand; much of the regional fish consumption includes products such as tuna, salmon, and sardines which are not caught in the Sound. If the commercial harvest in the Sound remains at the current level, the percentage of finfish products supplied by the Sound can be expected to decline as population and demand increase. Fishery products imported into the study region will continue to be the main source to meet these rising demands. The principal commercial finfish species are shad, winter flounder, scup, menhaden, bluefish, Atlantic mackerel, and striped bass. However, the commercial harvest of striped bass in Connecticut waters is illegal. Lobster, hard clams, and oysters are the principal commercial shellfish species, with lobster being the most important commercial species in the Sound from an economic viewpoint.

Sport fishing. Unlike the commercial fishery, the sport fishery has been constantly increasing. Striped bass, bluefish, winter flounder, summer flounder, Atlantic mackerel, tautog, and scup form the backbone of the sport fishery, with shad fishing being important in the Connecticut River. With the increased affluence and leisure time of the LIS population, sport fishing has become big business. This fact is particularly evident when striped bass and bluefish migrate through the Sound. In 1971, there were about 30 charter boats operating on the Sound, mostly at the extreme western and eastern ends.

No exact records are available, but it has been estimated that in 1970 there were about 341,000 salt-water anglers in Connecticut (Table 3). This is over 10 percent of the state's population! Estimates of fishing pressure from the north shore of Long Island and from Westchester County place the number of salt-water anglers there at about 477,000 salt-water fishermen; however, creel censuses are needed to determine more accurate statistics regarding the number of salt-water anglers and the relationship between salt-water sport fishing and the dynamics of fish populations.

The annual demand for salt-water sport fishing in the Sound is currently estimated at 9.8 million activity days (818,000 fishermen x 12 days fishing/fisherman). Long Island Sound is capable, at present, of supplying its sport fishermen with an adequate catch practically year-round. During January and February, persistent anglers can find striped bass near the heated discharge waters of power plants. Flounders are available from March until late June, with another run available in October. Striped bass, scup, bluefish, tautog, and (presently) weakfish are plentiful all through the summer months. Bluefish are especially prevalent in the late summer and into the fall, as are tautog and striped bass. Also, cod are available in the eastern end of the Sound in November and December.

With increasing human populations, sport fishing and recreational shellfishing demand is expected to increase significantly in the next 30 to 50 years in the LIS area. Table 3 shows that by 2020, the number of salt-water anglers in the Sound is expected to increase to 1,422,000. Recreational shellfishermen in the Sound are expected to increase from 12,000 to 19,000 by 2020.

TABLE 3. ESTIMATED RECREATIONAL SPORT FISHING DEMAND

Activity	Subregion	Fishermen (X 1,000)[1]			Fishermen days (X 1,000)[2]		
		1970	1990	2020	1970	1990	2020
Shell-fishing	1	2	2	3	10	10	15
	2	3	4	5	15	20	25
	3	1	1	1	5	5	5
	4,5	3	4	5	15	20	25
	6a	0	0	0	0	0	0
	6b,c	2	3	3	10	15	15
	7,8,9	1	2	2	5	10	10
	Subtotal	12	16	19	60	70	95
Salt-water finfishing	1	33	53	67	396	636	804
	2	16	32	42	192	384	504
	3	142	176	210	1,704	2,112	2,520
	4,5	150	188	228	1,800	2,256	2,736
	6a	124	146	163	1,488	1,752	1,956
	6b,c	197	231	247	2,364	2,772	2,964
	7,8,9	156	296	465	1,872	3,552	5,580
	Subtotal	818	1,122	1,422	9,816	13,464	17,064
Fresh-water finfishing	1	14	17	21	168	204	252
	2	8	10	13	96	120	156
	3	49	55	65	588	660	780
	4,5	53	58	71	636	696	852
	6a	1	1	1	12	12	12
	6b,c	10	11	12	120	132	144
	7,8,9	12	22	35	144	264	420
	Subtotal	147	174	218	1,764	2,088	2,616

[1]Based on data in 1970 Salt-Water Angling Survey and fresh-water license sales by the National Marine Fisheries Service.

[2]Based upon participation rates estimated at 5 fishermen days per shellfishermen and 12 fishermen days per finfisherman in both salt water and fresh water.

3.2 What is the capacity of the fishery to satisfy the public demand?

As stated earlier, the commercial fishery in 1974 was supplying only a small percent of the large (96 million pounds) demand for commercial fishery products in the study area. It is apparent that the Sound will not be able to raise production to anywhere near the current level of demand, much less meet the rising demands of the future. From a fundamental point of efficiency, therefore, most of the area's commercial demand will continue to be satisfied by import. Whatever the Sound can produce at competitive prices will have a local market.

For the sport fishery, however, demand-supply relationships are more meaningful. Although it is possible for the wealthier fisherman to move to distant waters, most sport fishing demands must be met in local waters. Since Table 3 showed that almost all of the sport fishing demand was for salt-water finfishing, only that activity will be pursued further in this consideration of demand and supply. Boats, docks, channels, water space, and additional shoreline access will be needed to meet the demand of the salt-water fisherman.

Table 4 defines the sport fish species, assumes a quality experience (which varies with the fishery and the fisherman), estimates the available supply if the commercial catch remains at its 1970 level, and shows the deficiencies (needs) in the future.

Although the needs in Table 4 are based on estimates of the number of fishermen presently utilizing the Sound, it must be emphasized that these figures are purely estimates based on the best available information. The most significant limiting factor, however, is the size of the fish populations, and further research is needed to adequately assess the impacts of recreational fishing in the future. For good sport fishing management, it will be necessary to increase biological knowledge in the following areas:

(a) the number of fishermen utilizing the Sound

(b) data on standing crop, recruitment, growth, total mortality and catch and effort relationships for finfish and shellfish populations of the Sound.

(c) intra- and inter-Sound migrational habits and movements of fish

(d) areas potentially valuable for artificial reefs, piers, or artificial islands

(e) methods for maintaining an annual optimum standing crop of sport fish

(f) factors which limit the fishery (i.e., water pollution, thermal addition, impoundments)

TABLE 4. RECREATIONAL SALT-WATER SPORT FISHING REQUIREMENTS, SUPPLY, AND NEEDS (in millions of pounds of sport fish[1] annually)

Subregion	Requirements[2]			Supply[3]	Needs[4]		
	1970	1990	2020		1970	1990	2020
1	2	3	3	1	1	2	2
2	1	2	2	2.5	(1.5)	(0.5)	(0.5)
3	7	8	10	2.5	4.5	5.5	7.5
4,5	7	9	11	2.5	4.5	6.5	8.5
6a	6	7	8	.5	5.5	6.5	7.5
6b,c	9	11	12	1	8	10	11
7,8,9	7	14	22	40	(33)	(26)	(18)
Regional total	39	54	68	50	(11)	4	18

[1]Major sport fish species consist of bluefish, striped bass, scup, winter flounders, mackerel, and tautog.

[2]Requirements computed on basis of 4 pounds of sport fish per sport fishing day to provide a quality experience. Estimate is based on data in 1970 Salt-Water Angling Survey and an assumed active sport fishing season of 3 months (90 days).

[3]Supply total is estimated annual yield of sport fish species listed in note 1 (less the commercial catch) based on catch data for the North Atlantic region as found in the 1970 Salt-Water Angling Survey. One quarter of the North Atlantic catch of the species in note 1 was estimated to have been caught in Long Island Sound. The estimate for the sustained annual yield is purely an assumption based on the estimated catch for the Sound. No actual true data exists for the sustained yield of sport fish populations. Distribution of supply is assumed to be as follows: 80% in subregions 7, 8, 9; 5% in subregions 2, 3 and 4, 5; 2% each in subregions 1 and 6b, 6c; and 1% in subregion 6a. Distribution percentages are based on the assumption that most fish are caught in the cleaner waters of the Sound (i.e., the eastern end).

[4]Needs are deficiencies i.e. requirements less supply. Entries in parentheses represent surpluses. Note that for 1970 the region as a whole shows a surplus, but that most of the individual subregions are deficient.

Note (Table 4) that generally only the most urbanized subregions are deficient as indicated in the needs column. For the next two decades, however, these subregional need may be counterbalanced by surpluses in subregions 7, 8, and 9.

3.3 What are the principal characteristics and species of the fishery?

Production. Of prime concern is the major decline in commercial landings of finfish and shellfish in the Sound since 1956. The decline in finfish landings is partially due to a decline in commercial harvesting effort, to regulations discriminating against commercial finfishing in favor of recreational finfishing, and, in some cases, to declining fishery stocks. This decline is especially evident in the otter trawl fishery. It must be pointed out, however, that the decline in Sound landings does not necessarily mean a decline in catch; the actual catch of some species in the Sound is on the increase e.g. menhaden. Commercial shellfishing decline is most probably linked to pollution and resultant closure of shellfish beds, wetlands modification and destruction, reduced commercial harvesting effort, and careless shellfishing practices including inadequate laws and inadequate enforcement of shellfish regulations.

Finfish. At the present time there are only four full-time commercial otter trawlers in the Connecticut waters of Long Island Sound. In addition to these trawlers, there are a number of commercial fishermen who occasionally trawl for finfish in the Sound. The Connecticut otter trawl catch in 1970 amounted to about 650,000 pounds, consisting of two major species, scup and winter flounder and unclassified bait species (i.e., menhaden, sea robin, skate, herring-like fishes, eel, and small flounder). There are fifteen seasonal commercial otter trawlers operating in New York waters of Long Island Sound, and their catch in 1969 also amounted to about 650,000 pounds. The three top species were butterfish, summer flounder, and scup. The locations of the otter trawl fishery and other Sound fisheries are shown in Plate 1 (Page 57).

Despite the decline over the past three decades, several smaller fisheries have remained stable. This includes the pound net fishery on the north shore of Long Island. It consistently contributes 300,000 to 500,000 pounds of fish to the commercial catch. The Connecticut River shad fishery contributes 100,000 to 200,000 pounds annually. Several small fisheries have also shown increases during the 1956-1970 period. This is true of the eel fishery which has a local product demand and an export market.

The recent menhaden fishery began on a large scale in the early 1940's. Landings in Long Island Sound fluctuated for several years, but have decreased significantly since the mid-1960's. Despite the decline in Sound landings, there is little doubt that the actual menhaden catch

for the Sound has increased in the past several years. Landing statistics for New Jersey to Rhode Island, inclusive, show menhaden landings increased from 40.6 million pounds in 1970 to 172.6 million pounds in 1973. It is likely that a large portion of these landings were caught in Long Island Sound.

Over 100 species of finfish are known in Long Island Sound. This includes cartilaginous fish such as sharks and skates, and many bony fishes. Table 5 summarizes the 61 most common species in the Sound. Many of the species are important along Cape Cod, Block Island Sound, Gardiners Bay, and the New York Bight, and occur in the Sound mainly as juveniles or during spawning. This is true of mackerel and herring, as well as others. The Sound, with its high concentration of plankton, tremendous quantities of bottom fauna, and its abundance of forage fishes, appears to be an excellent nursery area for smaller fishes (5). Plankton-feeding fishes such as menhaden and Atlantic herring utilize the Sound's planktonic resources, while the various flatfish feed on the dense population of worms and molluscs on the bottom. Many forage fishes such as the bay anchovy, the sheepshead minnow, several species of killifish, silversides, sticklebacks, grubby sculpin, goby, rock eel, and American sand-launce are common residents of the Sound. Oceanic species of fish usually enter the eastern and sometimes western ends of the Sound during the spring and summer. Fishes that may have been present during the colder months may leave in spring and summer as water temperatures increase in the Sound. Other species using the Sound during the summer may leave in the autumn when the temperature begins to decrease.

Spawning and nursery requirements vary a great deal with different species of fish. Menhaden enter the Sound in late spring and remain through September. Eggs of menhaden are pelagic and are released throughout the Sound. Post-larval menhaden then migrate into more estuarine waters along the Connecticut and Long Island shore for further growth before migrating out of the Sound and south for the winter. All estuarine areas in the Sound can be considered nursery grounds for this species. Similarly, other coastal and oceanic species which have pelagic eggs use most of the open Sound waters for spawning. This includes, for example, Atlantic mackerel. Tautog and bay anchovy are other common species that lay pelagic eggs in the Sound waters. Coves, bays, and deeper bottoms also support an intense late winter (February-April) spawning ground for the winter flounder. Many invertebrates also have pelagic larvae which use open Sound waters for development, particularly during May through September.

Table 5 indicates the type of bottom major species prefer. Many fish prefer clean sand or gravel bottom areas, and most of these areas are considered good nursery areas. These locations may have mysids or shrimp available for food organisms.

Finfish migration originates chiefly at the eastern end of the Sound although some migration occurs at the western end, even though polluted

COMMON AND SCIENTIFIC NAME	Relative Abundance		Residency		Utilization		Where Found: By Waters and Bottom.					
	Common	Less-common	Permanent	Seasonal	Sport	Commercial & bait.	Saline	Brack-ish	Fresh	Mud	Sand	Rock
Atlantic sturgeon Acipenser oxyrhynchus.	-	Endangrd Protectd	X	-	-	-	X	X	X	X	X	-
Shortnose sturgeon Acipenser brevirostrum.	-		X	-	-	-	X	X	X	X	X	-
Grubby Myoxocephalus aenaeus.	X	-	X	-	-	-	X	X	-	X	X	-
Shorthorn sculpin Myoxocephalus scorpius.	-	X	X	-	-	X	X	-	-	-	X	X
Longhorn sculpin Myoxocephalus octodecemspinosus.	X	-	X	-	-	X	-	X	-	-	X	X
Sea Raven Hemitripterus americanus.	X	-	X	-	-	X	X	X	-	-	-	X
Summer flounder Paralichthys dentatus.	X	-	-	X	X	X	X	X	-	X	X	-
Fourspot flounder Paralichthys oblongus.	-	X	X	-	-	-	X	X	-	-	-	-
Windowpane Scophthalmus aquosus.	X	-	X	-	-	X	X	X	-	-	X	-
Winter flounder Pseudopleuronectes americanus.	X	-	X	-	X	X	X	X	-	X	X	-
Hogchocker Trinectes maculatus.	-	X	X	-	-	-	X	X	-	-	-	-
Northern puffer Sphoeroides maculatus.	X	-	X	-	-	X	X	X	X	X	X	X
American eel Anguilla rostrata.	X	-	Y	-	-	X	X	X	X	X	X	X
Blueback herring Alosa aestivalis.	Y	-	-	X	-	X	X	X	X	-	X	X
Alewife Alosa pseudoharengus.	Y	-	-	X	X	X	X	X	X	-	-	-
American shad Alosa sapidissima.	Y	-	-	X	-	X	X	X	X	-	X	-
Hickory shad Alosa mediocris.	X	-	-	X	-	-	X	X	-	-	-	-
Atlantic herring Clupea harengus harengus.	-	X	-	X	-	-	-	-	-	-	-	-
Atlantic menhaden Brevoortia tyrannus.	X	-	-	X	-	X	X	X	-	-	-	-
Bay anchovy Anchoa mitchilli.	X	-	X	-	-	-	X	X	-	-	-	-
Brown trout Salmo trutta.	X	-	X	-	X	-	X	X	X	-	X	X
Rainbow smelt Osmerus mordax.	X	-	X	-	X	X	X	X	X	X	X	-
White catfish Ictalurus catus.	X	-	X	-	X	X	X	X	X	X	X	-
Oyster toadfish Opsanus tau.	X	-	X	-	-	-	-	X	-	X	X	-
Atlantic cod Gadus morhua.	-	X	-	X	X	-	X	X	-	-	X	X
Silver hake Merluccius bilinearis.	-	X	-	-	-	X	X	X	-	-	X	X
Atlantic tomcod Microgadus tomcod.	X	-	X	-	X	-	X	X	X	-	X	-
Pollock Pollachius virens.	-	X	-	X	X	-	X	-	-	X	X	X
Red hake Urophycis chuss.	-	X	-	X	-	-	X	X	-	X	X	-
Ocean pout Macrozoarces americanus.	-	X	X	-	-	X	X	X	-	-	X	-
Sheepshead minnow Cyprinodon variegatus.	X	-	X	-	-	-	X	X	-	-	-	-
Banded killifish Fundulus diaphanus.	X	-	X	-	-	-	-	X	X	X	-	-
Mummichog Fundulus heteroclitus.	X	-	X	-	X	X	X	X	-	X	-	-
Striped killifish Fundulus majalis.	X	-	X	-	-	-	X	-	-	-	X	-
Tidewater silverside Menidia beryllina.	X	-	X	-	-	-	X	X	-	-	-	-
Atlantic silverside Menidia menidia.	X	-	X	-	X	X	X	X	-	X	-	-
Northern pipefish Syngnathus fuscus.	X	-	X	-	-	-	-	X	-	X	-	-
White perch Morone americana.	X	-	X	-	X	X	X	X	X	X	X	-
Striped bass Morone saxatilis.	X	-	-	X	X	X	X	X	X	X	X	X
Black sea bass Centropristis striata.	-	X	-	Y	X	-	X	X	-	-	-	X
Bluefish Pomatomus saltatrix.	X	-	-	X	X	X	X	-	-	-	-	-
Scup Stenotomus chrysops.	X	-	-	X	X	X	X	X	-	-	-	X
Weakfish Cynoscion regalis.	X	-	-	X	X	X	X	X	-	-	X	-
Spot Leiostomus xanthurus.	-	X	-	X	X	-	X	X	-	-	X	-
Northern kingfish Menticirrhus saxatilis.	-	X	-	X	X	-	X	X	-	-	X	-
Tautog Tautoga onitis.	X	-	X	-	X	X	X	X	-	-	-	X
Cunner Tautogolabrus adspersus.	X	-	X	-	X	-	X	X	-	-	-	X
American sand launce Ammodytes americanus.	X	-	-	-	-	X	X	X	-	-	X	-
Atlantic mackerel Scomber scombrus	X	-	-	X	X	X	X	X	-	-	-	-
Butterfish Peprilus triacanthus.	X	-	X	-	X	X	X	X	-	-	X	-
Northern sea robin Prionotus carolinus.	X	-	-	X	-	X	X	X	-	-	X	-
Striped sea robin Prionotus evolans.	X	-	-	X	-	X	X	-	-	X	X	X
Sand Tiger Odontaspis taurus.	X	-	-	X	-	X	X	-	-	X	X	X
Sandbar shark Carcharhinas milberti.	X	-	X	-	-	X	X	-	-	-	X	-
Smooth dogfish Mustelus canis.	X	-	-	Y	-	X	X	X	X	X	X	-
Spiny dogfish Squalus acanthias.	X	-	-	Y	-	X	X	-	-	-	X	X
Little skate Raja erinacea.	X	-	-	Y	-	X	X	X	-	X	X	-
Big skate Raja binoculata.	X	-	-	Y	-	X	X	X	-	-	X	-
Clearnose skate Raja eglanteria.	X	-	-	Y	-	X	X	X	-	X	X	-
Barndoor skate Raja laevis.	-	X	X	-	-	X	X	X	-	X	X	-
Roughtail stingray Dasyatis centroura.	-	X	-	X	-	X	-	-	-	-	-	-

conditions exist at well-documented levels. Certainly, the eastern end of the Sound is of primary importance as a migratory entrance, and environmental modifications in this area could significantly alter migratory conditions Future imporvement in the water quality at the western end could improve the availability of this water as a migratory route.

Connecticut fresh-water streams are a valuable resource for anadromous fish where impoundments do not occur, where the flow is adequate to supply sufficient oxygen and prevent siltation, and where clean sand, gravel, and rubble is present. The Connecticut River is presently the greatest resource area for white perch, American shad, blueback herring, alewife, smelt, and eels.

The states of Connecticut, Massachusetts, New Hampshire, and Vermont, as well as the United States Fish and Wildlife Service and the National Marine Fisheries Service, have agreed to support a fisheries program for the Connecticut River Basin. The objectives of the Connecticut River Restoration Program are to realize the full potential of the fishery resources of the River, mainly salmon and shad. The intent of this program is to provide the public with high quality sport fishing opportunities in a highly urbanized area, as well as to provide for the long-term needs of the population for seafood.

American Shad -- Historically, the Connecticut River supported shad runs as far upstream as Bellows Falls which lies in the River between Vermont and New Hampshire, approximately 35 miles north of the Massachusetts border. The exact magnitude of the historic run is unknown, but it might have approached six million adult fish at the mouth of the river. It probably would not be possible to restore the run to its historical numbers, but an evaluation of present spawning and nursery areas as far north as Bellows Falls indicates that a run of up to two million fish could be realized. The two million figure is based on the production of 2.3 adult shad produced per 100 square yard unit of spawning habitat. The 2.3 figure assumes rather low production since production as high as 6.5 adult shad per unit has been realized.

Atlantic Salmon -- The magnitude of the original salmon run in the Connecticut River is unknown, although there are many historical references that indicate that the run was sizable and originally went as far as Beecher Falls near the Canadian border. Utilizing a unit area technique similar to that used with shad and evaluating the river as far as the Cummerford Dam, reveals a potential run of adult salmon at the river's mouth of 38,000.

Present restoration projects for the Connecticut River Atlantic salmon and American shad reflect concern for the decline of these fisheries. The same is true of other anadromous fishery species in Connecticut, particularly the alewife, a fishery resources which is presently being researched along with glut herring, sturgeon, and striped bass for management purposes.

In 1955 the Connecticut State Board of Fisheries and Game began a sea trout program which has met with some success and is a current ongoing project. The main objective of this program was to establish trophy-sized sea-run brown trout in selected coastal streams.

Coastal streams and rivers, which have been stocked with this species are Saugatuck River, Westport; Branford River, Branford; Hammonasset River, Madison; Salmon River, Leesville; Latimer Brook, Niantic; Thames River System; and Whitford Brook, Mystic.

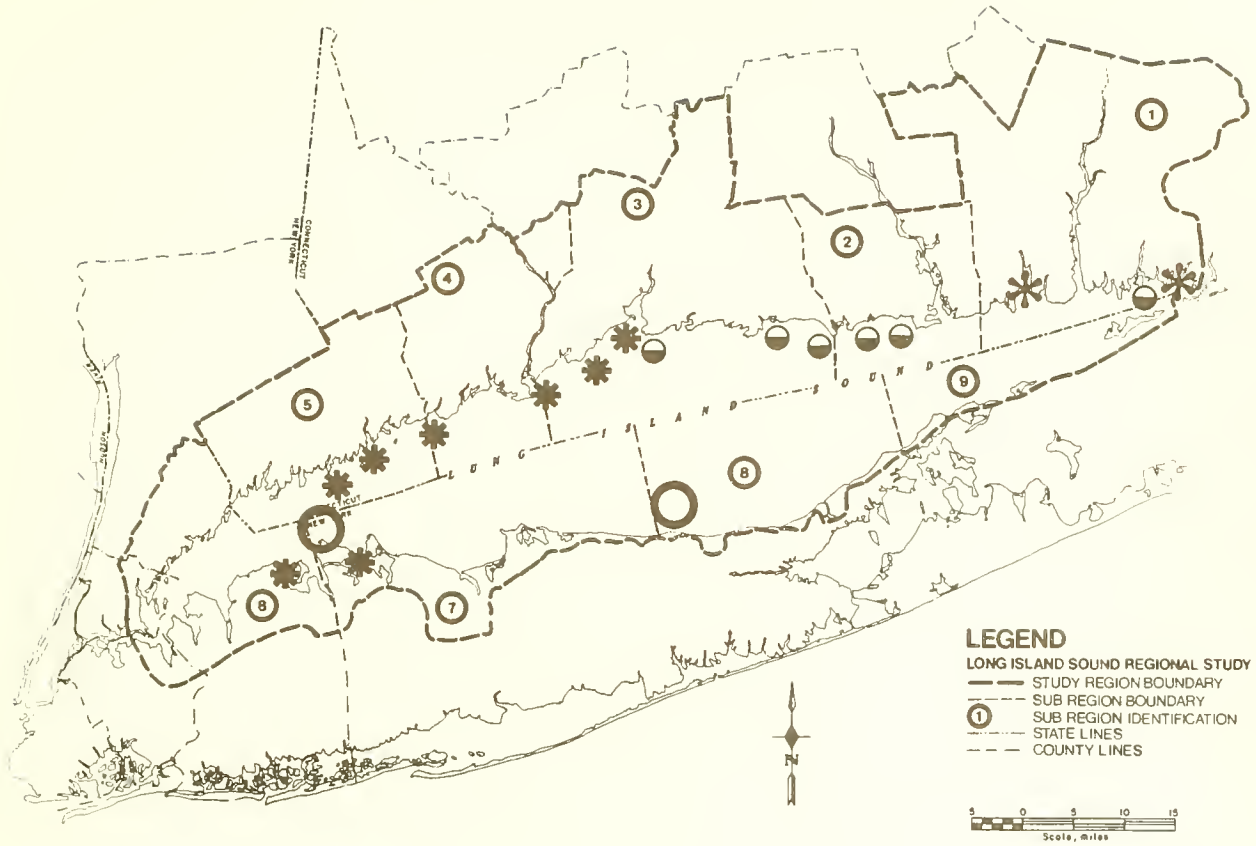
To date, a small run of sea trout has been established in Latimer Brook, in Niantic. Some of these trout range in weight from one to fourteen pounds. Whitford Brook in Mystic, stocked recently, has been fairly successful, but the size of the fish is much smaller, one to three pounds. The largest trout caught by an angler came from Latimer Brook and weighed eleven pounds.

Another anadromous fisheries management plan attempted in Connecticut was the Coho salmon project. The Coho salmon, native to the Pacific Northwest, was selected in an attempt to establish an anadromous species in the Thames River System. Coho salmon eggs were originally shipped from Oregon to Connecticut in 1966, and smolts (young fish) were stocked in 1968 in the Thames River System. Attempts were made also in 1970 and 1971 in Latimer Brook, Niantic. While it is apparent that this species is not suited to Connecticut waters, possibly due to high temperatures in Long Island Sound during spawning time, future plants of sea trout may be attempted where the Coho has failed.

Management and utilization of fishery resources in waters of Long Island Sound and its contiguous bays and harbors are formally governed by the laws and regulations of various agencies. Some of these regulations are designed to contribute to the conservation of fishery resources, while others have come about for social reasons such as protection of the public health, the favoring of one group of harvesters over another, or through resolution of conflicts involving fishery interests versus other users of the resource area. Additional regulations effecting modifications of the marine edge and waste disposal in Long Island Sound are also of importance to the fishery. The effectiveness of these regulations varies from place to place. In many areas, the regulations probably are inadequate.

Molluscan shellfish. Molluscan shellfish have played an important role in the history of Connecticut and New York. They were a highly important food of the Indians before the colonization of the area and were also an important food in the diet of the local colonial population as growth increased. Oysters from Long Island Sound were consumed throughout the Northeast, and large shipments were sent to Europe and the western coast. Other species of shellfish were harvested and consumed in significant numbers, but mostly by local residents; these were hard clams, soft clams, bay scallops, and mussels. In recent years, hard clams and mussels have been shipped to more distant markets, as has conch. Some shellfish stock locations are depicted in Figure 2.

New York and Connecticut have 783,000 acres of actual or potential shellfish-growing areas. However, approximately 100,000 acres are closed to shellfishing because of pollution. The majority of the clam and oyster havesting occurs withing the bays and harbors, while the mussel, conch, squid, and lobster fisheries occur in the Sound.



Oyster stocks

Bay scallop stocks

Mussel stocks

Conch concentrations

Figure 2. Locations of various shellfish species within Long Island Sound.

Oysters are probably the product most associated with Long Island and Long Island Sound, but the history of LIS shellfish utilization is tragic. At the turn of the century the industry's production was estimated at 22.5 million pounds of meats annually, valued at approximately $10 million. In the late 1800's there were 1,024 men on 453 vessels engaged in the fishery; in 1970, only 208 men and 30 vessels were active, landing a catch worth only $641,700. The Connecticut production of oysters during the 1930's was as high as five million pounds, but since the mid-1950's until recently, it has averaged about 320,000 pounds per year (see Figure 3). In New York, oyster production has

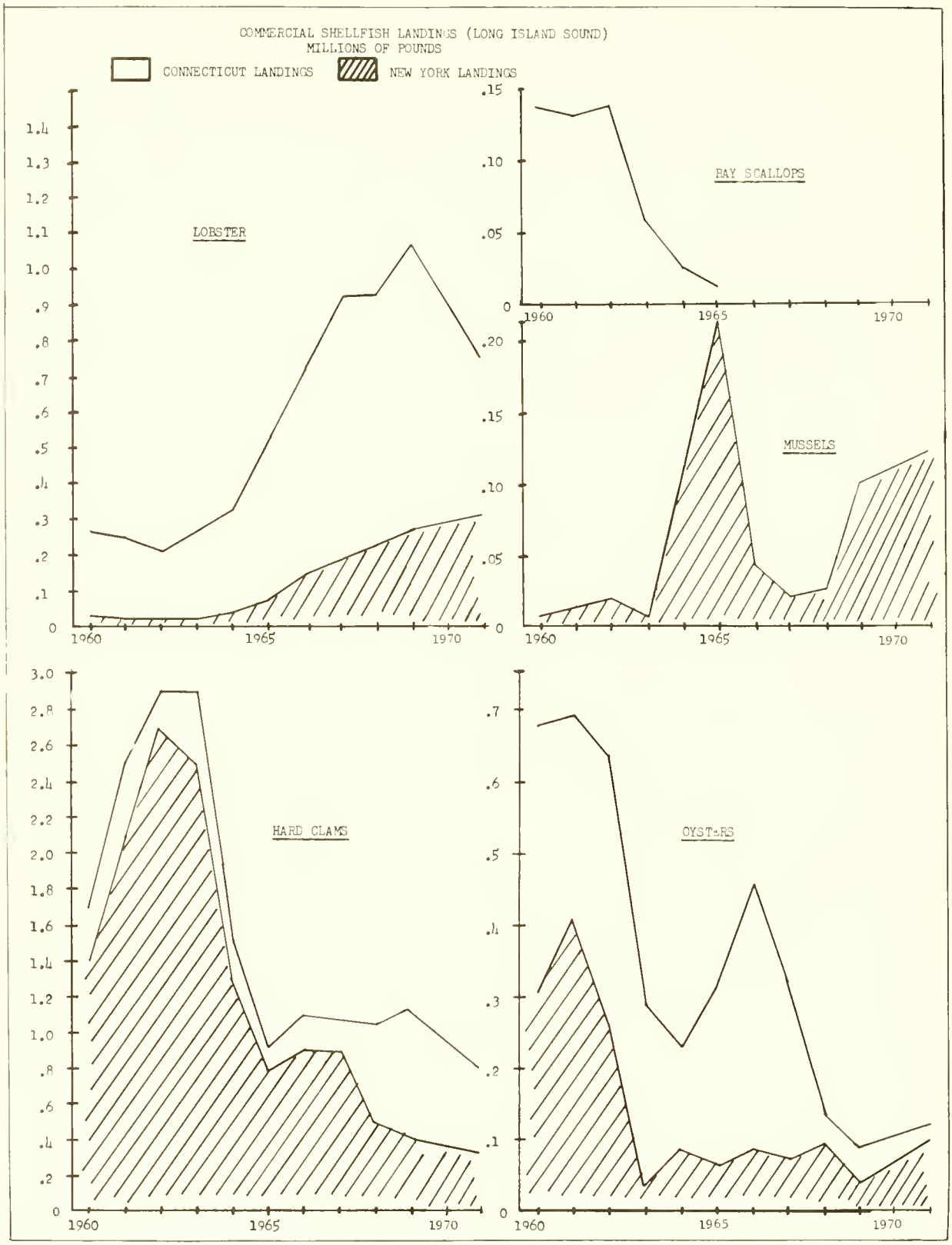


Figure 3. Commercial shellfish landings in Long Island Sound in millions of pounds.

fluctuated (Figure 3), but has remained only slightly greater than 100,000 pounds. Some improvement in natural setting has occurred since 1970, and moderate increases in production under existing conditions have been obtained with modern methods of intensive oyster culture.

As an alternative to natural sets that are subject to natural fluctuations in success and abundance, several companies have constructed hatcheries in which adult oysters are induced to spawn, and then the larvae are reared and set under controlled conditions. Raft rearing of oysters to maturity has not yet been successfully accomplished in Long Island Sound due to difficulties with weather, economics, and certain legal problems associated with leasing procedures. If economically successful, raft culture could be a method for increasing oyster production.

Studies are now being done on improving the genetic stock of the oyster. Genetically induced changes resulting in increased size or reduced period of commercial growth are now possible, as are increased ranges of tolerance to environmental factors, enhanced ability of larvae to set under adverse conditions, and improved resistence to disease. For these improvements and natural population stability, it is now thought essential to have adequate wild stocks of oysters for any cultured or intensively-grown crop. Wild stocks constitute a valuable and irreplaceable source of genetic variability for a culture population of animals or plants.

Of shellfish other than oysters, hard clams are historically the more important species. From the 1930's through the 1960's annual production of clams in Connecticut ranged between 10,000 and 470,000 pounds with a value from $4,000 to $76,000. In New York waters of Long Island Sound, during the 1960's, the harvest rose as high as 926,000 pounds valued at $815,000. Recent data show a decline in hard clam landings but the value of hard clams has continued to rise (Figure 4). Cultivation of hard clams is now being tried at shellfish hatcheries under controlled conditions.

Shellfisheries for scallops and soft clams have declined to the point of little importance commercially. Both shellfisheries could improve with improved water quality and new management programs. Culture of scallops may be a possibility. Commercial landings of mussels and conch (Table 6) have shown a rise in 1970, even though this is small in relation to other shellfisheries.

The Connecticut Department of Agriculture, Aquaculture Division, and the New York Department of Environmental Conservation are responsible for the administration and management of state-owned public shellfish grounds. New York State grants leases for about 2,000 acres on the north shore of Long Island and another 4,300 acres are leased by the towns of Oyster Bay and Huntington. Connecticut State controls about 27, 000 acres which are under lease or franchise. The total number of town-leased beds in Connecticut is approximately 2,400 acres.

Figure 4. Mean annual value (price paid to the fisherman) of shellfish landed in New York from LIS area, 1965-1973. Data have not been adjusted to standard dollars.

Management of State shellfish grounds at the present time is aimed primarily at supervising all activities and establishing policy relating to the leasing of grounds, approval of transfers, collection of rentals and taxes, designation of spawning areas, reviewing of permits for dredging or construction, regulating types of gear, and setting minimum size lengths for soft and hard shell clams.

Management of town-controlled shellfish grounds is focused on the regulation of the resource in regard to "bag limits", season, and size. Management by private oyster companies consists of predator control, periodic moving of seed oysters to growing areas, and the transfer of marketable oysters to nonpolluted waters for cleansing and purification.

TABLE 6. NEW YORK AND CONNECTICUT LANDINGS OF CRUSTACEAN AND MOLLUSCAN SHELLFISH (in pounds) FROM LIS[+] (Dollar value to fisherman in parentheses)

	Northern Lobster	Hard[++] Clams	Soft Clams	Sea Mussels	Conch Meats	Oysters	Squid
New York							
	(46)	(736)	(5)	(31)		(110)	(1)
1965	67	846	14	209	--	68	16
	(127)	(815)	(4)	(6)		(155)	(2)
1966	151	926	15	41		82	17
	(172)	(887)		(5)		(163)	(5)
1967	181	887	--	17	--	75	67
	(239)	(472)	(1)	(8)	(5)	(213)	(5)
1968	236	434	2	25	26	99	69
	(275)	(471)	(6)	(29)	(4)	(106)	(2)
1969	267	432	15	97	18	48	18
Connecticut							
	(660)	(101)			(7)	(283)	(8)
1968	696	241	--	--	32	121	132
	(830)	(124)	(.08)		(19)	(195)	(27)
1969	804	303	.1	--	929	86	269
	(720)	(218)			(37)	(228)	(6)
1970	671	282	--	--	151	125	31

[+]All figures in thousands.

[++]Univalve and bivalve mollusks are reported in pounds of meats.

Crustacean shellfish. Lobsters have always played an important role in the history of Long Island Sound fisheries (Figure 5). In recent years they have been the most economically important shellfish species harvested (Table 6). The rapid growth of this fishery has been phenomenal. In Connecticut, during the period of 1958 to 1969, the total number of licensed fishermen increased from 316 to 1,532. The catch increased from 207,000 pounds to 800,000 pounds and the estimated number of licensed pots increased from 16,000 to 62,000.

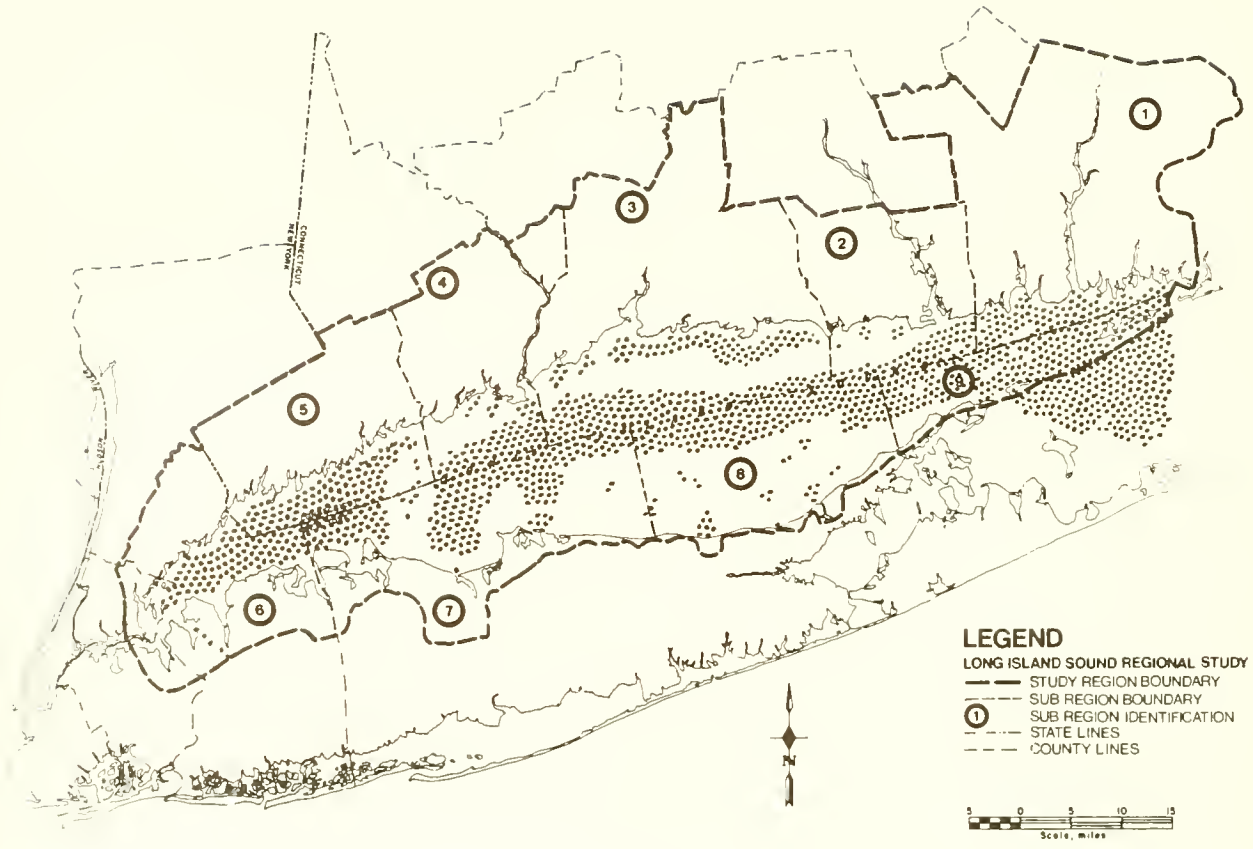


Figure 5. Lobster concentration areas in Long Island Sound.

New York has experienced a similar, if not more striking, increase in lobstering activity even though the total catch is less than that of Connecticut. In 1958, the New York catch was a mere 7,500 pounds or 3 percent of the total Sound catch of lobsters. By 1970, the total rose to 330,000 pounds or 33 percent of the total Sound lobster catch.

Efforts to develop a unified management program for American lobster (Homarus americanus) were initiated in early 1972 as an attempt to stem further decline in stock abundance and to improve economic and social resource values. By August, the Northeast Marine Fisheries Council, composed of fishery administrators and scientists from eleven coastal states (Maine through North Carolina) and the National Marine Fisheries Service (NMFS) had met and launched a comprehensive State-Federal lobster management program. Such a program was needed to coordinate the development and implementation of coastwide management practices to ensure a viable fishery and to enhance the socio-economic benefits obtainable from the resource.

In August, 1972, two committees were formed to provide continuity of effort and effectiveness in lobster management deliberations. The American Lobster Subcouncil, composed of State fishery administrators and the Regional Director of NMFS, was established to provide overall program guidance and to facilitate implementation of decisions through existing legal and institutional channels. A second committee, the Lobster Scientific Committee, consisting of scientists from each state and from NMFS, was founded to formulate lobster management plans and to coordinate program operations. The Lobster Scientific Committee is responsible for recommending to the Subcouncil those practices considered necessary for the efficient and rational management of lobsters. Coastwide lobster management precepts enacted upon in August, 1972 included proposals regarding controlling total fishing effort on the resource, law enforcement, minimum legal carapace length, maximum size limit, possession of egg-bearing lobsters, prohibiting the notching of female lobsters, use of escape vents on lobster traps, and licensing.

3.4 What are the major limitations on productivity?

The major limitations on secondary production are loss of habitat and general deterioration of water quality. Biological communities develop along with their environment, and reflect its conditions, resources, and variability. Many changes in water brought about by man's polluting activities have adversely endangered or altered the existence or quality of aquatic life. Changes in sediments, oxygen levels, and quantities of harmful wastes, due to dredging and waste disposal, effect a reduction in the abundance of certain macro-algae and benthic animals, and may cause significant changes in fish fauna and fisheries. The effects of waste disposal on benthic environments can extend beyond the immediate impact areas for considerable distances. Component contaminants such as heavy metals and coliform bacteria may show distribution patterns. Disposal areas usually show reduced species diversity, and even small organisms known to be extremely tolerant and resistent to the effects of polluted conditions, may be found in diminished numbers. Crabs and lobster in waste disposal areas appear to be highly susceptible to disease, ulcerations, shell erosion, gill tissue erosion, and fouling and necrosis of gill tissue, all of which probably lead to increased mortalities in these areas. Finfish also appear to be susceptible to disease, particularly types of fin rot. It is possible that heavy metals may contribute to this susceptibility.

Loss of habitat. Perhaps the major limitation to secondary production in the Sound area is the loss of habitat, particularly wetland habitat. The Sound wetlands are an invaluable source of food and shelter for numerous fish and wildlife. Realizing their value, surveys of the wetlands of Long Island Sound were made to determine the rate of wetland loss. In 1953, the U. S. Fish and Wildlife Service (6) conducted a nationwide wetlands inventory to determine the location, quality, and acreage of remaining wildlife wetlands. A resurvey of the high and moderate value wetlands of Long Island and Connecticut was conducted in the spring and early summer of 1959 (7). In 1964, a second resurvey was conducted (8) (9). The data from these surveys provided a basis for estimating the wetland losses along the Sound. Of 17,018 acres of Connecticut wetlands existing in 1953, 2,179 acres (12.8%) were destroyed by 1964. Of 43,214 acres of Long Island's entire marsh habitat existing in 1953, 12,635 acres (29%) had been lost by 1964. By 1964, after considerable losses, 75 percent of the remaining Connecticut wetlands and 88 percent of the remaining Long Island wetlands were considered vulnerable to destruction. Although no specific estimate of losses or vulnerability was made for wetlands on the north shore of Long Island, they most likely followed the island-wide pattern.

On Long Island, housing, miscellaneous fill, recreational development and industry accounted for 84 percent of the losses which occurred during the period 1953-1964. In Connecticut, the same developments accounted for 78 percent of the wetland losses. In addition to the direct destruction of tidal wetlands, subtle alterations in the quality of the remaining wetlands have decreased their value. Siltation from adjacent fill, diking, tide gateing, drainage, and certain types of mosquito control have induced physical changes in the marshes, thus reducing their value as food producers and as habitat for wildlife.

Hopefully, wetland losses have come to a virtual stop because legislation in Connecticut and New York (1969 and 1973, respectively) has made it difficult to obtain permits for the filling of wetlands. About 8,000 of the remaining 11,000 acres of wetlands along Long Island's north shore are in town or village hands. Connecticut's remaining wetlands are estimated at about 15,500 acres. The general location of Long Island Sound wetlands is depicted in Figure 6. A complete listing of the wetlands of Nassau and Suffolk Counties is available in a supplementary report (10).

Deterioration of water quality. Domestic pollution has been increasing and spreading along the coasts. Consequently, virtually all shellfishing in western Long Island Sound for oysters, clams, and mussels has been prohibited because of deterioration of water quality. The locations of and reasons for the closures for New York and Connecticut waters are summarized in Appendix D. A number of these shellfish beds have been closed within the last few years. Hopefully, if improved sewage control is initiated in the near future, these areas will be more easily restored.

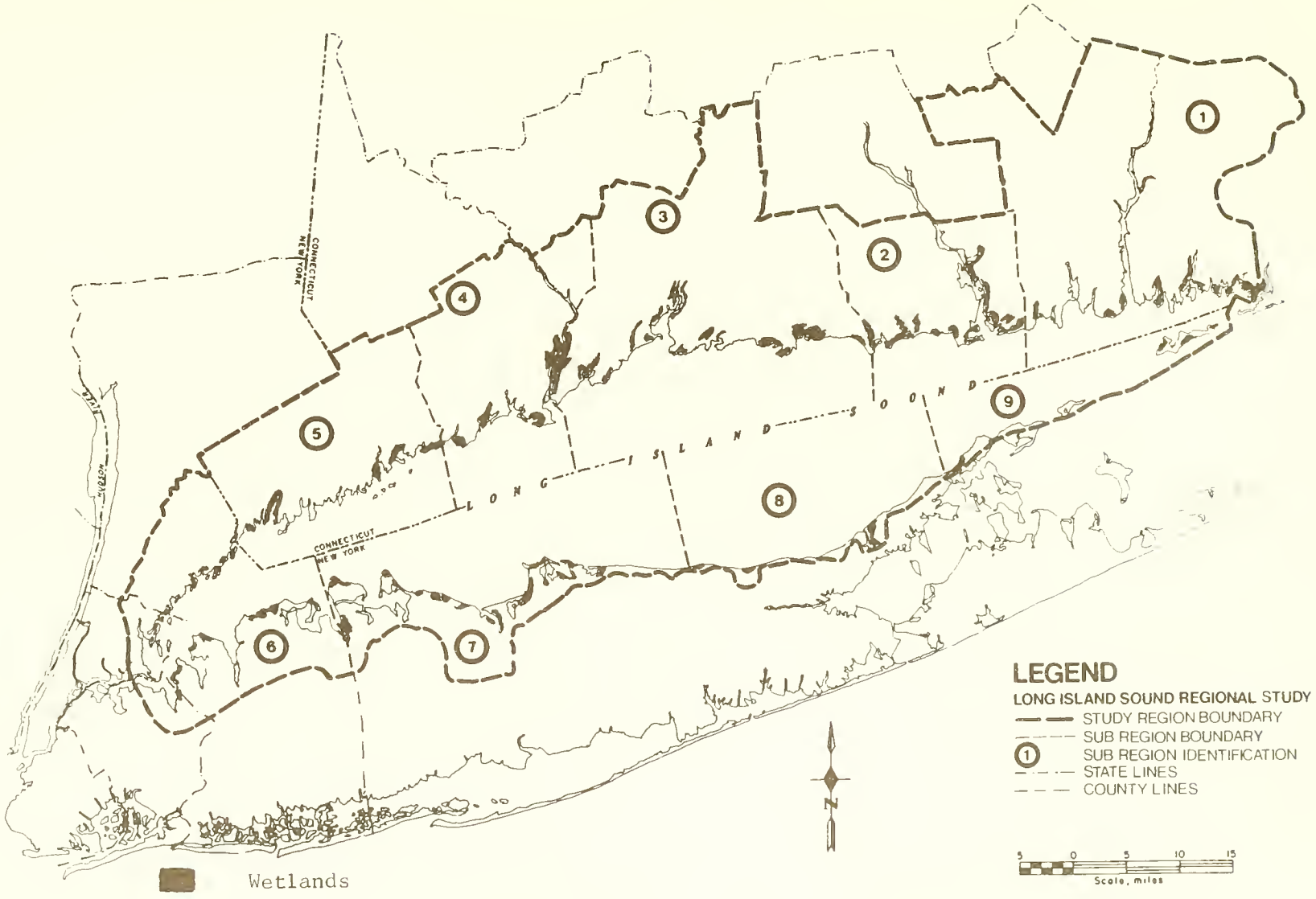


Figure 6. General location of LIS wetlands.

4.0 THE WILDLIFE

4.1 How is wildlife important to the public?

Aesthetic qualities. Hunting and fishing are not the only activities which make the LIS wildlife important to the public. Birdwatching, hiking, and nature photography are as important to environmental satisfaction as are hunting and fishing. In the LISS region, only a small percentage of the population engages in hunting or fishing activities, but the numbers who enjoy hiking or birdwatching far outnumber the former. An estimate of the LIS population interested in "non-consumptive" wildlife activities, based on data in the 1970 National Survey of Fishing and Hunting, shows approximately 210,000 birdwatchers, 150,000 bird and wildlife photographers, and 810,000 nature hikers in the LISS region. On Long Island alone, there are 62 nature preserves and sanctuaries, 20 of which are located on the north shore. Thousands of people visit these areas annually, actively participating in the enjoyment of viewing wildlife species in their natural environment.

Another source for the aesthetic appreciation of wildlife species lies within the LIS region's park system. The attendance at parks in urban areas is particularly high since, in many instances, parks are the one source of "nature" available to the local residents. In Eisenhower Park (Nassau County) alone, over one million picnics were held in 1973. While these persons are not actively engaged in birdwatching or nature hikes within the parks, the presence of birds, squirrels, chipmunks, and other wildlife adds to the attraction of the park area.

The increased awareness of the importance of wildlife per se is evidenced not only by the numbers of birdwatchers and photographers, but also by the popularity of environmental studies programs introduced into school curricula. These programs are designed not only to provide an understanding of the ecological systems within the environment, but to emphasize the role of wildlife species in making the systems work. Such programs, aimed at educating the public environmentally, will hopefully lead to greater appreciation of wildlife and wildlife habitat.

Hunting. In 1970, the estimated number of hunters for Connecticut and the Long Island area totaled approximately 16,000 (Table 7).

Waterfowl and small game hunting constitute the principal hunting activities in the LISS area. Mallards, black ducks, green-winged teal, and greater scaup comprise most of the waterfowl kill, but the species found in the greatest numbers are scaup and scoter (Table 8).

Table 8 shows the abundance of waterfowl along the LIS coastline. Note that the total Long Island waterfowl populations, as estimated in this table, tripled between 1960 and 1970. The relationship of the coastal wetlands to the abundance and survival of these wintering populations is of vital importance. The wetlands serve as a major wintering terminus for

TABLE 7. APPROXIMATE HUNTER PARTICIPATION IN THE LISS AREA FOR 1970
(All figures X 1000)

Region	Participants		
New York (Long Island)	Big Game	Small Game	Waterfowl
6a		.3	.03
6b, 6c		.5	1
7,8,9	1	4	4
Total	1	5	5
Connecticut			
5,4	.03	.5	.07
3	.04	2	.2
2	.2	.5	.1
1	1	1	.04
Total	1	4	.4

certain migratory birds from the Labrador-Quebec-Newfoundland region and, as such, they provide habitat for the migratory populations of the Atlantic Flyway. The fact that these populations can fluctuate unevenly over a period of years (Table 8) suggests that they are highly susceptible to environmental changes. Further loss of wetland habitat in significant proportions could lead to drastic reductions in the waterfowl populations of the Sound, as well as those of the Atlantic Flyway.

Little information is available for hunter kill by species of upland game in either Connecticut or Long Island. The most recent information for Long Island are the data provided by the New York State Department of Environmental Conservation (Table 9), and this is only for two small cooperative hunting units run by the State, both of which are outside the Sound Study boundaries. Pheasant and cottontail represent major portions of the small game harvest for both Long Island and the LISS portions of Connecticut. Actually, most hunting on the north shore of Long Island is done on private lands, and very little, if any, hunter kill information is available for these areas.

Hunting demand was determined from present hunting participation figures and projected population figures as adjusted for the LISS region. It must be emphasized that the hunting demand projections are estimates based solely on statistics. No empirical judgments were attempted. As shown in Table 10, all subregions except 6a, 6b, and 6c showed an increase in hunting demand for small game. Waterfowl hunting demand showed increases in all subregions with the greatest increases occurring in Suffolk County. Whether or

not these future demands will be satisfied depends primarily on the game available to the hunter and ultimately upon the habitat available to the game species. Hunting areas (habitat) in the LISS region are essentially finite, fixed resources, and it is the habitat itself which becomes the limiting factor for hunting, not the population resource. Because hunting demands are not satisfied at the present time, it is unlikely that increased hunting demands will ever be satisfied. However, effective management programs will attempt to insure a quality hunting experience for as many as possible without destroying the resource.

TABLE 8. WATERFOWL POPULATIONS FOR THE LIS COASTLINE

Long Island[+]	1955	1960	1965	1970
Black duck	7,000	16,085	8,415	19,782
Mallard	262	2,431	1,486	6,907
Baldpate	85	1,302	958	931
Scaup	10,849*	885*	62,410	51,160
Canvasback	675	2,970	1,777	3,488
Goldeneye	263	851	717	555
Old Squaw	28	641	335	759
Scoter	1,554	8,420	4,916	20,009
Bufflehead		558	451	1,339
Geese & Brant	161	871	864	3,386
Merganser		3,396	2,735	1,794
Mute swan		343		455
Total	20,877	38,753	85,064	110,565

Connecticut[++]	1966	1970
Sea ducks	13,950	29,177
Dabbling ducks	3,475	9,431
Geese	350	1,150
Total	17,775	39,758

[+]Data are from the New York State Department of Environmental Conservation aerial surveys; 1955 data are for one month only but 1960-1970 data are for three months.

*Scaup and Redhead

[++]Data are from Connecticut State Board of Fisheries and Game, Mid-winter Inventory of Waterfowl.

TABLE 9. HUNTER KILL OF SMALL GAME BY SPECIES IN THE LIS AREA.

	Species[+]				
	P[o]	Q	C	S	G
New York* (Long Island)					
1970	220	380	600	90	31
1971	100	270	580	110	30
1972	160	290	370	130	44
Connecticut[++]					
1970	930	400	311	200	140

[+]P = pheasant, Q = quail, C = cottontail, S = squirrel, G = grouse

[o]Pheasant are stocked in the Long Island and Connecticut hunting areas.

*Data are taken from hunting activity reports for Navy Dept. Cooperative Unit and Ridge-Middle Island Cooperative Unit, Suffolk County, New York. Cooperative Unit data are disproportionately high in regard to number of hunters and low in regard to kill. Total hunting area for these units is about 8,200 acres.

[++]Harvest is for area within LISS boundaries.

TABLE 10. PROJECTED HUNTING DEMAND IN TOTAL MAN-DAYS FOR LISS REGION.

Region	Small Game			Waterfowl		
	1970	1990	2020	1970	1990	2020
6a	34	31	18	165	190	210
6c	54	49	28	710	830	890
7,8,9	430	820	1,300	2,100	4,000	6,300
Subtotal	518	900	1,346	2,975	5,020	7,400
5,4	144	178	216	38	46	54
3	427	529	630	85	106	124
2	226	323	439	65	92	125
1	320	399	483	23	29	34
Subtotal	1,117	1,429	1,768	211	273	337
TOTAL	1,635	2,329	3,114	3,186	5,293	7,737

4.2 What is the capacity of the region's wildlife resources to satisfy the public demand?

Present environmental conditions. The wetlands complex of Long Island Sound, consisting of salt marsh, estuaries, mud flats, bays, coves, and sand dunes, supports over 150 species of mammals, birds, reptiles, and amphibians (11) (12). The wetland value to wildlife is based on the carbon cycle associated with wetland plant life. The single most important element in the complex is the salt marsh, and the most important plant species are the Spartina grasses. Spartina grasses (particularly Spartina alterniflora) provide the detritus upon which the wetland complex and its value to wildlife is based. Marsh detritus is the principle link between bacteria, algae and other marine plants, and the remaining wetland community. It is this complicated but finely balanced production system that makes the wetland complex so valuable as wildlife habitat.

The absolute value of Long Island Sound wetlands to wildlife is difficult to assess. Economic benefits associated with draining or filling a marsh for housing or industrial purposes are easy enough to measure, but value in terms of habitat and aesthetics is not so easily quantified. The most serious threat to the remaining Long Island Sound wetlands is the various activities associated with population increases and attendant housing needs. By 1990 about 550,000 new dwellings, replacement of 30,000 obsolete dwellings, and at least 400,000 new jobs will be required in Nassau and Suffolk Counties -- based on population projections and present housing needs (13). Space requirements for the increased work force are estimated at 8,250 acres. The projected housing requirements associated with increased populations in Connecticut indicate a need for an additional 130,000 new homes in the LISS region (14). Draining and filling wetlands for housing, recreational facilities, and other purposes (sand and gravel mining, boating access, shore and harbor protection projects, etc.) often become self-defeating in that the natural setting which attracted development is often destroyed in the development process. Clearly, the long-term benefits of the Sound wetlands must be considered if we are to preserve their natural value.

Wildlife supply. Despite reduced wetland areas, Connecticut and Long Island share an abundance of varied wildlife forms. Each is particularly rich in species of waterfowl, shore birds, marsh birds, and upland birds. Among the more commonly observed waterfowl are mallards, black ducks, scaup, and scoter (11). Plovers, snipe, terns, crows, warblers, and robins also frequent the area. Starlings and house sparrows are extremely abundant. Large birds of prey fairly common to the Sound region include six owl species and two hawk species. Long Island and Connecticut also provide habitat for a variety of salamanders, snakes, turtles, frogs and toads. Also prevalent are the opossum, woodchuck, gray squirrel, muskrat, and a variety of shrews, bats, and mice. Typical upland game species include ruffed grouse, cottontail, quail, dove, and deer. In addition to land animals, the Sound hosts a number of marine animals: the bottle-nosed dolphin, common dolphin, and harbor porpoise are sighted occasionally in and around the Sound. A list of all the wildlife species including their habitat preferences, food and nesting requirements, location and status within the study area, and an evaluation of their dependence on wetland areas is contained in a supplementary study report (12).

Rare and endangered species are those animals whose numbers have become or are in danger of becoming so low that the population's reproductive rate cannot keep pace with the death rate. Among the large birds of prey, the osprey, peregrine falcon, Cooper's hawk, sharp-shinned hawk, and the yellow-crowned night heron are considered rare in the LIS area. These birds still find suitable habitat in the remaining salt marshes of Long Island Sound, although many of them only visit or rest during certain seasons. The Sound region also provides habitat for two amphibians and one reptile considered rare, the cricket frog, the eastern spadefoot toad, and the bog turtle. Two species of whales, the humpback and Atlantic right whale, classified as endangered, have also been seen occasionally in or near the east end of the Sound. Seriously over-harvested, there are only a few hundred surviving members of each of these species. The river otter, once prevalent on Long Island and in Connecticut's rivers and streams, is now occasionally seen after a 50-year period of virtual extirpation from the region. The short-nose sturgeon is also considered rare, but a few can be found in the lower Connecticut River.

The list of rare and endangered species (11) continues to increase. Hopefully, the Long Island Sound area will continue to provide refuge for these species as well as a suitable habitat for the more abundant wildlife forms.

Based on information obtained from the New York State Department of Environmental Conservation and the Connecticut Department of Environmental Protection, upland woodlands and farms are the primary habitat types encountered in the LISS region (15). However, wetlands and immediately adjacent upland areas are extremely valuable on the basis of their role in nutrient recycling, and as nursery, feeding and resting areas for fish and wildlife. In this respect, they far outrank upland woodlands and farms in regard to habitat supply.

In addition to upland and wetland habitat bordering the Sound region, many islands within the Sound itself provide living space for numerous wildlife forms, including additional shoal water areas for fish, shellfish, and various marine invertebrates. Most of these islands are located off the Connecticut coastline. The islands, particularly those near Norwalk, are frequented by herons, osprey, marsh hawks, waterfowl, and hundreds of migratory and upland birds. Habitat type ranges from marsh to woodland to rock (16). Many of these islands are of great value as rookeries and nesting habitat for rare and/or endangered birds (osprey, some heron species) and, as such, should be preserved in their natural state.

5.0 TENTATIVE PLANNING OBJECTIVES

The goal of the Long Island Sound Regional Study is to produce a plan of action by February, 1975, which balances the needs to protect, conserve, and wisely develop the Sound and its related shorelands as a major economic and life-enriching resource for the 12 million people who live near it.

This goal may be attained by reflecting society's informed preferences for attainment of two overall coequal study objectives, as established by the U.S. Water Resources Council.

1. Environmental Quality (EQ), which enhances the quality of the environment through the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

2. National Economic Development (NED), which increases the value of the Nation's output of goods and services and improves national economic efficiency.

For this report on Fish and Wildlife, the tentative planning objectives are:

- To sustain the natural biological productivity of the Sound's ecosystem including the Sound's shoreland and upland wildlife resources.

- To increase the economic value and public enjoyment of the Sound's marine resources.

To meet these tentative planning objectives, alternatives will be formulated and evaluated in terms of environmental, economic, and social well-being criteria. Three plans will be developed, one emphasizing EQ, one emphasizing NED, and one reflecting a composite of the two plus some additional social well-being (SW) considerations. Tentative recommendations and specific proposals are listed in Section 8.0.

6.0 EVALUATION OF ALTERNATIVE MEASURES

In Appendix C, each of the alternative measures is evaluated in terms of a number of environmental, economic, and social criteria developed to reflect guidance contained in the Principles and Standards of the U.S. Water Resources Council, environmental impact statements, and other sources. Table 12 is a summary of the matrix in Appendix C.

6.1 Major environmental considerations

As reflected in Table 11, environmental criteria favor measures that insure continued natural productivity of the Sound. They are relatively neutral to measures such as improving availability of fishing grounds, improving fishing access, or expanding port landing facilities, provided these measures are properly supervised. They are adverse to measures which would cause or sustain significant or irreversible environmental change.

TABLE 11. SUMMARY EVALUATION OF ALTERNATIVE MEASURES

Alternative fish and wildlife measures	Environmental Quality (EQ)	National Economic Development (NED) & Reg. Development (RD)	Social Well-Being (SW)
Establish fishery management/ research programs	Good	Good	Good
Preserve/create/restore wetlands	Good	Poor	Good
Establish public environmental education programs	Good	Fair	Good
Establish additional wildlife management areas	Good	Good	Good
Acquire islands as wildlife management areas	Good	Fair	Fair
Maintain or increase species diversity	Good	Good	Good
Improve water quality	Good	Poor	Good
Improve fisheries habitat	Good	Fair	Good
Establish uniform size and bag limits	Good	Good	Fair
Improve access for fishing	Fair	Good	Fair
Improve availability of fishing grounds	Fair	Fair	Good
Promote underutilized species	Good	Good	Good
Expand port landing facilities	Fair	Fair	Fair
Establish assistance programs for the commercial fisherman	Fair	Fair	Fair

The following premises are particularly significant:

1) The salt marshes, mud flats, estuaries, and dunes which form the shoreland-upland interface exist within a delicate ecological framework, which is extremely susceptible to even slight environmental changes. This interface is of great importance to the marine food chain, and disruptions to it will usually result in disruptions in the food chain at some level. Such disruptions may cause only short-term effects, but others may result in irreversible losses. Dredging and filling activities, oil spills, deteriorating water quality, and pesticide pollution are generally considered to perpetrate long-term and, at times, irreversible losses to the shoreline environment. In view of the latter's effects, any activities leading to the above incidences would be strongly objected to on an environmental basis.

2) Another environmental consideration is the importance of habitat and species diversity. A major requirement for preserving such productivity is the avoidance of conditions which would lead to the domination of one species within a system. Controlling fishery (including shellfishery) harvest, controlling public access to wetland areas, promoting habitat management of upland areas, and establishing fishery management programs are methods that will assure protection of the Sound's habitat and fishery resources.

3) A third environmental consideration is the active improvement of fishery and wildlife habitat. Many of the Sound's natural areas have given way to development, and what areas remain are often badly degraded or are in danger of destruction. A primary method for upgrading those areas which are polluted is the improvement of water quality. Better sewage treatment, including identification and treatment of non-point pollution sources, and stricter enforcement of existing water quality regulations regarding the dumping of industrial wastes and dredging and filling activities would help to improve water quality. Other positive measures to improve fishery and wildlife habitat include creating and restoring wetland areas, establishing upland wildlife management areas, and establishing artificial reefs.

6.2 Major economic considerations

As reflected in Table 11 economic criteria favor cost efficient measures which will guarantee a high return on expenditures. They are neutral with respect to measures that exhibit a one to one benefit-cost ratio, but they are generally adverse to measures involving loss of developmental land or resulting in low benefit-cost ratios.

Among the cost efficient measures suggested are programs that would (1) make use of available funds, (2) increase the market value of a product or introduce new market items, and (3) lead to more efficient uses of a resource. Alternative measures which would promote the consumption of underutilized fish and shellfish species would not only add additional products to the market but could serve to localize a fishing industry which, at the present time, transports its catch to areas outside the LIS region. Associated benefits of such a program include increased numbers of marketable items,

increases in employment, and corresponding catch increases for the commercial fishing industry. Recreational fishing programs for underutilized species would also increase personal fishing satisfaction and economic returns to the community.

Economic criteria are, of course, adverse to measures which would result in economic loss or great economic burden. From this viewpoint, measures dealing with water quality improvement, preservation of wetland areas, and acquisition of islands for preserve areas would not rate favorably. The economic objections to such programs are based on either low benefit-cost ratios or outright lack of knowledge concerning the quantitative value or cost of a particular program. However, while it is not always possible to attach a cost to an environmental program, it must be emphasized that such factors do not always signify a poor economic risk. Wetland preservation programs, for example, while difficult to evaluate on a unit cost basis, can lead to economic returns in terms of erosion control, improved water quality, and increased fishing, hunting, and other recreational opportunities.

6.3 Major considerations of social well-being (SW)

Social criteria (Table 11) favor most of the alternative measures, particularly those which will provide access to or increase utilization and appreciation of the Sound's natural resources, such as establishment of fishing piers, improvement of fishing access (improving polluted shellfishing and finfishing areas, increasing the number of boat rental facilities) and establishment of wildlife management areas. Social criteria are relatively neutral to measures which will limit use of these resources to some degree, such as the eventual establishment of uniform size and bag limits for sport fish, establishment of a marine fisheries management/research program, and acquisition of islands as wildlife management areas. They are opposed to measures which would force redevelopment and relocation.

6.4 Measures to sustain the natural biological productivity of the Sound area

Establish marine fishery management/research programs. Without basic knowledge of how the Sound's ecosystem functions, it is difficult to implement specific future recommendations since so many programs are dependent on this biological information; thus, this recommendation is of primary importance in this study. Perhaps the most important question which needs to be answered is the capability of specific fishery resources to be utilized over the long term without detrimental changes; any degree of overfishing would most probably result in declining fish and shellfish populations and may result in loss of the resource for future generations.

In addition, a main consideration of fishery management/research programs would be to manage the resources for public enjoyment and satisfaction. In this respect, numerous benefits would be available to sport fishermen. These benefits would include construction and maintenance of piers, establishment of artificial reefs, the purchase of additional fishing access sites on the shoreline, and the construction of boat launching ramps.

Future studies need to be conducted in the following areas:

(1) Document and compile natural history surveys of the Sound's various resident species (winter flounder, tautog, oysters, hard clams) in order to permit an evaluation of existing management regulations and to provide a rational basis for future management. Such surveys would include data on biological parameters such as standing crop, recruitment, growth, total mortality, and catch and effort relationships.

(2) In order to better manage migratory species in the Sound, cooperative management programs must be established within an interstate/international framework.

(3) Efforts should be made to identify and describe the natural habitats available in the LISS area to provide a means to evaluate actual and potential biological resources.

(4) In order to quantify our knowledge of the LIS ecosystem, the energy pathways must be defined.

(5) Commercial and recreational fishing demands must be documented and evaluated.

These programs need to be implemented in order to prevent dominating environmental changes, constraints, or deterioration.

The cost of this fishery management/research program is estimated at approximately 12 million dollars spread over the next 5 - 10 years. This estimate includes not only the cost of research studies but the costs of fishing piers, access sites, artificial reefs, and environmental education programs. Funds to support these programs are available through several sources. They could possibly be funded through existing legislation such as P.L. 88-309 - Commercial Fisheries Research and Development Act, P.L. 89-304 - Anadromous Fish Act of 1965, or through NOAA's Sea Grant Program for university research. Other means include use of funds available through the Dingell-Johnson Act of 1950, use of nonrebated gasoline taxes, small apportionments of the boater registration fees, and revenues from a salt-water licensing program.

Non-rebated gasoline taxes could be directed to fishery management programs. This policy has recently been introduced in the state of North Carolina and presently all non-rebated gasoline tax monies obtained by the Marine Division of the Department of National and Economic Resources are being utilized exclusively for construction and maintenance of artificial reefs. In California, fishery management programs (i.e. construction and maintenance of fishing piers) are supported through a small apportionment of the paramutual funds. The success of these programs should be evaluated to determine if such undertakings would be applicable in this area.

Salt-water sport fishing licenses would provide a double source of revenue for fishery management programs. Not only would revenues be available from the sale of the licenses, but additional monies would be derived from a greater apportionment of the Dingell-Johnson funds. The Dingell-Johnson Act of 1950, which levies a 10 percent excise tax on all fishing tackle, authorizes that these tax monies be apportioned and returned to the individual states for management of fishery resources. Apportionment is based on the number of licensed fishermen in the state and the area of each state, including coastal and Great Lakes waters. At present, two coastal states (Texas and California) have a state-wide salt-water fishing license program.

The major problems foreseen in establishing fishery management/research programs are socially and economically oriented. The public must be made aware of the importance and necessity of such programs. Presently, no accurate data are available regarding the precise impacts of sport or commercial fishing on the fishery resource, and this impact must be determined in order to establish a good fishery management program for the future.

Political and legal problems are anticipated in obtaining funding for these programs. The use of non-rebated gasoline taxes to help support these programs would obviously necessitate state legislative action. The major disadvantages associated with salt-water licensing arise from the opposition of many sport fishermen. Most of their objections to licensing are based on possible misuse of the license revenues. However, if license revenues are ear-marked specifically for management of the marine fishery resource, then the monies can be used to construct piers, to promote small boat rental facilities, to establish artificial reefs, or to purchase additional access rights on rivers and shoreline for fishing, all of which will be to the benefit of the salt-water sport fishermen.

Preserve/create/restore wetlands. Any effort to maintain the natural biological productivity of the Sound area must center on the preservation and management of the Sound's wetlands. Both tidal salt marshes and inland fresh-water wetlands contribute significantly to the productivity of the Sound's ecosystem, serving as nursery and spawning habitats, sediment traps, pollution filtrants, and as primary links in the marine and fresh-water food chains. Preservation efforts would be directed towards insuring wetland quality with such programs as (1) maintenance of a "buffer zone" within which no development would be permitted, (2) stricter adherence to sewage outfall and dredging and filling regulations, and (3) limitations of public access to wetlands on a seasonal basis. Also many additional salt marsh areas could be restored if fill material and/or Phragmites communis were removed, the proper grading was restored, and the area was planted with Spartina alterniflora. At the present time, there are ongoing wetland restoration programs in Fairfield County, Connecticut and in the Town of Huntington, New York. Objections to wetland preservation would most likely be based upon economic concerns dealing with loss of developable land.

As a flood control measure, many tidal impoundments have been installed along the Sound coastline, particularly in Connecticut. Unfortunately, when these tidal impoundments were installed, some salt marshes began to

deteriorate due to lack of tidal flushing. Lack of salt water caused a change in vegetation resulting in the dominance of less desirable species. Other hindrances to tidal flushing, including road culverts of inadequate size and poor maintenance of mosquito ditches, have also served to cause salt marsh deterioration.

Re-opening some wetland areas to tidal flushing will help to re-establish marshland. Increasing the size of road culverts, removing or not maintaining tidal impoundment in carefully selected areas, and improving mosquito ditching methods to prevent salt marsh areas from drying out will insure growth of Spartina alterniflora and S. patens, the marsh grasses which form the basis of wetland productivity. Restored wetland areas will provide nursery and spawning grounds for fish and shellfish and additional habitat for coastal upland bird and wildlife.

This measure presents economic and social difficulties. Economically, it will lessen development possibilities. Social objections will come from those persons whose homes would be subject to tidal flushing if tidal gates were removed or not maintained.

Establish public environmental education programs. An effective environmental education program would attempt to develop a sense of inquiry concerning our natural resources and a commitment to a continuing awareness of Man's responsibility for these resources. In such a densely populated area as the metropolitan-Sound region, emphasis on development has prevailed to the point of deterioration in some places. For the future, the ways in which people comprehend their environment is of significant importance. To impress upon Man his dependence and integral role with nature, environmental education programs and nature centers can be most conducive to learning.

Within federal structure, most agencies have recognized the value of such programs and support them through the National Park Service, U.S. Fish and Wildlife Service-Wildlife Refuge System, and many others. Within State and local systems, the U.S. Office of Education has made Title III grants available through the Elementary and Secondary Education Act of 1965. Town conservation agencies can promote and establish centers for educational and public use, and conservation groups can develop certain areas to promote conservation aims and awareness.

Environmental education programs have high environmental quality contributions and receive continuing local support. The major oppositions to such programs usually are derived from conflicts in local school system programming and are resolvable. This proposal does not generally reduce NED and RD proposals and benefits, but does provide extremely high social well-being attitudes.

Establish additional wildlife management areas. Proposed management areas would include inland wetlands which are as important to upland ecology as tidal wetlands are to the marine ecosystem. They provide habitat and food for black ducks, mallards, wood ducks, rabbits, fox, raccoon, deer, and many other upland species. Inland wetlands are generally more susceptible to

developmental pressure than tidal wetlands and, as such, must be preserved to assure their continued contribution to the environment. This is not to say that these areas cannot be used for any other purpose. Multi-purpose use of an area is not necessarily detrimental. Recreational (hunting and fishing) use of such areas, if properly managed, can enhance the overall productivity of a preserve by harvesting populations of certain game species such as deer, rabbit, muskrat, and beaver that could multiply drastically if not controlled. Multi-purpose preserve use will also help to satisfy the demand for nature hiking and birdwatching.

Economic disadvantages involve loss of land available for development. However, this loss is expected to be minor since most of the wildlife management areas are to be established in State forests and parks. Some minor legal problems are expected concerning methods of acquisition and administrative responsibilities.

Acquire islands as wildlife management areas. Many of the islands in the Sound, particularly those islands along the Connecticut coast, provide habitat for herons, osprey, and other wildlife species. To allow anything but very limited public use of these islands would only result in accelerated deterioration of their fragile ecological systems. Guided access and permit programs are examples of control mechanisms for protection purposes. Birdwatching, nature study activities, or waterfowl hunting would probably not affect the island habitat, but opening these islands to boating, swimming, camping or housing development would certainly result in considerable habitat loss. On the other hand, some islands may be suitable for limited or increased development.

Social and economic objections to this recommendation are raised on two grounds: (1) some of the islands are presently used for boating, swimming, and picnicking, and it would be difficult to legislate for wildlife management acquisition if the island is presently used or planned for active public recreation, and (2) the question of State or local acquisition of these islands poses a tremendous economic problem. The economic burden may possibly be eased by considering for acquisition only those islands of prime quality. It may also be possible to transfer some of the recreational demand for (duck) hunting, fishing, swimming, and boating to other islands in the Sound which can handle greater use.

Maintain species diversity. To maintain or increase species diversity several techniques may be employed. These include mowing, periodic thinning and cutting of wooded areas to promote the growth of underbrush, establishment of artificial habitat (wood duck houses, osprey platforms), and letting some agricultural fields remain fallow to allow for the growth of shrubs, grasses, and other seed-producing plants. Such measures will increase the numbers of game species and will also provide habitat for more secretive animals and birds. Greater species diversity will provide for greater hunting opportunities as well as enhanced opportunities for "non-consumptive" enjoyment.

No major objections are foreseen for this program.

Improve water quality. The probable effect of improving water quality will be greater species diversity and greater availability of fishery nursery areas, and spawning grounds. With the passage of the national law restricting the use of DDT, some of these effects may have already been observed. It is hypothesized that certain species (shrimp, blue crabs and fiddler crabs) have shown increasing population levels as a result of improved water quality. Clean water will also increase availability of shellfish populations. Improved water quality will benefit the Sound's natural resources and will provide for more aesthetically pleasing surroundings. Greater opportunities for recreational and commercial fishing are expected.

Some of the major disadvantages to upgrading water quality include the tremendous cost of advanced sewage treatment and the increased costs of goods passed on to the consumer by industry because of more stringent effluent standards which result in increased production costs. Other problems foreseen are the socio-economic impacts involved with transferring septic systems to sewage plant treatment.

Improve fisheries habitat. Habitat improvement would result in increased production of finfish and shellfish, provided water quality were upgraded. The major programs dealing with habitat improvement involve (1) establishment of artificial reefs which enhance habitat for species such as tautog, scup, and black sea bass, (2) improvement of wetland areas, and (3) improved methods of shellfish culture, such as raft culture, rehabilitation of bay bottoms, and modernized purification programs.

The major disadvantage foreseen is the adverse socio-economic reaction to the cost of water quality improvement which directly relates to habitat utilization. The costs of other habitat improvement measures (artificial reefs and wetland programs) are expected to be met by present funding legislation and should not be prohibitively expensive.

Establish uniform size and bag limits. Establishing uniform size and bag limits for finfish and molluscan shellfish must be considered a conditional recommendation dependent on research results regarding population levels of the fish in the Sound. Presently, little is known of the optimum sustainable yield of any of the Sound's major sport or commercial fish populations. Until research is able to determine the numbers, age of maturation, fecundity, and the exploitation rate of the endemic finfish and shellfish populations in the Sound (migratory species are not considered here), data needed to establish uniform size and reasonable bag limits are unavailable. The most important biological fact that must be determined is the level of optimum sustainable yield that the resources of the Sound can tolerate. Once this is known, and should research efforts determine that the sustainable level of the resource is, in fact, being reached, then this conditional recommendation should be implemented. Uniform bag limits must also include bag limits on total catch if fishery populations are to be maintained in optimum condition. If harvest were not controlled under these circumstances, then overfishing and eventual depletion of the fishery stocks would most probably result. Establishment of uniform size and bag limits would assure protection for the fishery and at the same time, it would insure fishing opportunities for present and future generations.

Should this conditional recommendation be implemented in the future, it must be understood that establishing uniform size and bag limits in New York and Connecticut would not have a great effect on the management of migratory fish species such as bluefish, striped bass, and mackerel. Management of these species will depend on cooperative agreements between several states, and, in some cases, between countries (17). The Sound's resident species such as tautog (blackfish), flounder, lobster, and shellfish are best suited for bistate management programs.

Some problems are anticipated in changing present size and bag limits to uniform agreements between New York and Connecticut, i.e. there may be major political opposition based (1) on present differences in size limits that exist between New York and Connecticut, (2) on questions of enforcement responsibilities, and (3) on the socio-political impacts involved with stricter regulation of the commercial and sport fisherman's catch.

Preliminary efforts have been made in regard to lobster management along the eastern coast of the United States. Although further research must be done to determine population levels in the Sound and actual lobster maturity, the preliminary research results and present management practices are being used to establish an initial lobster management program. This program includes recommendations regarding size, harvest, and attendent regulations. These management precepts include the following specific proposals:

1. A program shall be developed to effectively control total fishing effort on the lobster resource.

2. Reciprocal enforcement between States shall be effected.

3. All States shall establish a uniform minimum legal carapace length of 3-½ inches with no State at less than 3-3/16 inch carapace length by January 1, 1976.

4. Maximum size limit shall not be imposed on the lobster fishery.

5. All States shall enact uniform laws prohibiting the possession of egg-bearing or scrubbed lobsters.

6. All States shall enact uniform laws prohibiting the landing of lobster meat.

7. All States shall enact laws prohibiting the notching of female lobsters.

8. All States shall enact uniform laws prohibiting the possession of detached tails, claws or parts of lobsters.

9. All lobster traps shall incorporate an escape vent of a size adequate to minimize retention of sublegal lobsters.

10. All fishermen and primary dealers shall be licensed and shall be required to keep daily records of their activities on forms provided by the licensing agency.[4]

These recommendations of the Lobster Scientific Committee, under the auspices of the Northeast Marine Fisheries Council, should be evaluated for Long Island Sound by both New York and Connecticut. If these recommendations are found to be biologically justifiable, they should be accepted.

6.5 Measures to increase the economic value and public enjoyment of the Sound

Improve access for fishing. Recreational salt-water finfishing demand is estimated at 9.8 million fishermen-days and is expected to increase significantly over the next 50 years to 17 million fishermen-days. One method of accommodating the increased numbers of fishermen is to provide additional access points for fishing. Existing sea walls, groins, and jetties provide excellent fishing, provided they are accessible. Some power plants and other industrial facilities also have suitable fishing access points, but usually these points are not open to the general public. Another method to improve fishing access, particularly for children, low income groups, and the urban fisherman, is to increase the numbers of fishing piers along the Sound shoreline. Also, additional charter and party boat facilities could provide increased fishing access without increasing private boat ownership and marine development.

Since federal funds have been used to build some jetties and groins in the LISS area, general public access should be available. However, many of these areas are inaccessible due to private land ownership, and legal difficulties are anticipated in obtaining public access.

Improve availability of fishing grounds. Recreational and commercial shellfishing could be improved if water quality were upgraded. Improved opportunities for shellfishing can be accomplished by revitalizing existing beds (bottom restoration), developing new beds, and employing improved aquaculture techniques such as raft culture, modernized depuration techniques, and improved hatchery methods. Recreational shellfishing could be enhanced through the cooperative efforts of commercial interests in restoring depleted areas for public use.

[4]Precepts enacted upon in August, 1972 by the Lobster Scientific Committee.

The major disadvantages to the above measures include socio-political opposition to the reopening of commercial fishing areas, conflicts between commercial and recreational fishermen over the use of existing beds, and the economic costs of reopening or revitalizing shellfish beds. However, even though these disadvantages must be considered, it appears that benefits would be high. Combined with a comprehensive management/research program and increased assistance programs to the commercial fisherman (i.e., more sophisticated equipment), benefits of fishery improvements of $4.4 million per year (projected $88 million for the next 20 years) could be feasible due to increased sustainable landings.

Another method to increase fishing opportunities is to construct fishing piers. Much of the recreational fishing demand for the LIS region occurs in the western regions of the Sound where access and facilities are limited. Fishing piers would help to satisfy a portion of this recreational demand, particularly for the urban fisherman, including children, who cannot afford a private boat and expensive equipment. Some fishing piers should be located at State parks, thus eliminating the need for providing additional parking facilities. Others should be located in selected urban areas and towns where parking and/or transportation facilities are available and where interest in such construction is determined to be high.

About the only objection to this measure is the cost of construction which ranges between $75,000 and $175,000/pier depending on materials used and the length and shape of the pier. Also, maintenance costs contribute to the overall cost of a pier. Subsidization monies may be available to local governments, particularly for piers within town or village jurisdiction. Benefits are expected to outweigh costs. Some adverse environmental effects associated with pier construction are expected, but long-term impacts are considered negligible.

Promote underutilized finfish and shellfish species. Promotion of underutilized finfish (cunner, sea robin, dogfish) will open new resources to the sport and commercial fishermen, particularly the urban fisherman. One method to promote the use of these species would be to establish a public educational program which would include distribution of (1) pamphlets which could be used for identification of the species and (2) other brochures regarding the various ways to prepare, cook, and serve the fish. Utilization of these species should help to alleviate the pressures placed on the presently desirable species which may in the future be at levels in which the demand exceeds the supply. Promotion of underutilized shellfish (mussels, conch, and squid) would also widen the market available to the public.

No major objections to this program are foreseen.

Establish/expand port landing facilities. The north shore of Long Island has three harbors with active finfish landing facilities (Greenport, Port Jefferson, and Mattituck) and eight harbors (Port Washington,

Oyster Bay, Northport, Mt. Sinai, Huntington, Port Jefferson, Setauket Harbor, and Kings Point on the Nissequogue River) with active shellfish landing facilities. Connecticut has four active shellfish landing areas (Niantic, New Haven, Montville, and Norwalk). At present, many of the finfish landing facilities in Connecticut are classified as inactive due to a decline in fishing effort and harvest. The Stonington Harbor facilities and the Connecticut River shad landing facilities remain active, but the volume of landed fish has declined.

Upgraded facilities or newly-established facilities might draw local Sound catches, many of which now land outside the Sound area, back to the local harbors. Establishment of holding facilities immediately adjacent to the fishing sites or ports is needed. Such measures would make fresh fish available to local markets, would reduce wear on boats and equipment, and reduce operating expenses for the fishermen.

Minor environmental and social disadvantages associated with the construction of landing facilities and increased boat traffic are foreseen. Also, the costs of such facilities may be prohibitive in terms of the return which can be expected; however, it should be understood that the establishment and expansion of port landing facilities would be part of a comprehensive fisheries management program.

Assistance programs for the commercial fishermen and re-evaluation of commercial fishing regulations. Assistance programs in terms of grants to be used for research purposes, tax exemptions, and equipment loans could help to rejuvenate the Sound's commercial fishing industry. Equipment loans could be financed through the Federal Fishing Vessel Mortgage and Loan Insurance Act, or possibly through FHA loans.

The increased efficiency of commercial harvesting brought about by better equipment and greater catch per unit effort could have a favorable effect on the Sound's finfish populations in terms of elimination of waste associated with the catch of undesired species. Advanced equipment would favor the catch of "target" species over the mixed bag harvest. Of course, the "target" species catch may also be subject to regulation to prevent over-fishing problems. More sophisticated equipment and gear could also help the fishermen to track and harvest the species in less time and perhaps result in a more reasonably-priced product ashore.

Fishing regulations which discriminate against the commercial fisherman should be re-evaluated. For example, there is no proven biological basis for (1) the prohibition of the commercial harvest of striped bass in Connecticut waters, (2) otter-trawling and purse-seining prohibitions for the western end of the Sound, and (3) gill-netting prohibitions. Many of these regulations have resulted from the controversy between sport and commercial fishermen regarding which fishermen are entitled to the major portion of the catch. Unfortunately, these laws have been enacted on the basis of emotion rather than fact. New York and Connecticut should work together to re-evaluate these laws to assure justice for all fishermen.

Some economic problems are foreseen in obtaining financial assistance for commercial fishermen. The major problems involved in re-evaluating the laws governing the commercial fisherman are legal and political; there may be difficulty in getting old laws repealed.

Proposed fish and wildlife projects. The above descriptions were necessarily general. Most of the measures are implemented in the form of specific projects which are described in Table 12. Where possible, cost and benefit figures are given, but for some measures only a subjective "high" or "medium" value could be ascertained.

7.0 FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

In this section, three alternative plans are formulated -- one emphasizing the environmental quality objective (EQ), one emphasizing the national economic development objective (NED), and a composite plan. One of the plans is then selected as the recommended plan. Entries for each plan were developed from evaluation provided in Appendix C, from projects described in Table 12, and from the evaluation of individual measures discussed in Section 6.

7.1 Environmental Quality Plan

Narrowly construed, the fish and wildlife environmental quality plan would address itself only to those objectives which would result in significant benefit to the Sound's ecosystem. Such a plan would include all measures except (1) improving fishing access, (2) increasing the availability of fishing grounds, (3) establishing port landing facilities, and (4) providing assistance programs for the commercial fishermen. These programs rated only "Fair" on an environmental basis. In the interest of reaching eventual harmony with other objectives, however, the EQ Plan also includes those measures rated in Table 11 as "Fair under EQ and "Good" under either NED or SW. On this basis, then, the EQ Plan includes all the alternative measures listed in Appendix C.

The benefits and costs of each recommended program cannot always be quantified, but, on the whole, benefits are high. Some measures such as water quality improvement, environmental education programs, and acquisition of islands, while costly, are extremely beneficial from an environmental viewpoint. Those measures which are environmentally and economically efficient include fishery research programs, promotion of underutilized marine species, and expansion of wildlife management areas with corresponding maintenance of or increase in species diversity (Table 11).

7.2 National Economic Development Plan

Narrowly construed, a NED Plan would recommend only measures that would significantly contribute to that study objective. Under that constriction, a NED Plan for the LISS region would include only (1) increasing fishing access and (2) promoting underutilized marine species, both of which rated "Good" on an economic basis. In the interest of reaching eventual harmony

TABLE 12. PROPOSED FISH AND WILDLIFE PROJECTS

Project	Establish fishery m/r programs	Establish salt-water license	Use of non-rebated gasoline taxes	Preserve wetlands	Increase tidal flushing 1	Establish educational programs	Acquire islands	Improve water quality	Establish artificial reefs	Increase fishing (boat) access 2	Establish fishing piers	Promote underutilized species	Establish port landing facilities
Subregion													
1					Stonington (2) Groton (1) Waterford (1)	Harkness Memorial Park	Dodge Andrews	Thames River,			Harkness Memorial Park, Ocean Beach		Stonington Harbor Mystic Harbor
2					Clinton (1)	Salt Meadow Ridge	Menunketesuck	Conn. R. Hammonasset R					
3					Madison (2) Guilford (1) Branford (1,2) New Haven (1) West Haven (1,2) Milford (2)	Hammonasset State Park, East Shore State Park		Housatonic R., New Haven Harbor, Branford R., Milford Harbor	Hammonasset State Park, New Haven Harbor		Hammonasset State Park, New Haven		
4					Stratford (1) Fairfield (1)	Great Meadow		Bridgeport Harbor	Bridgeport Harbor		Bridgeport		
5					Westport (3) Darien (1) Greenwich (4)	Sherwood Island State Park, Shea Island	Chimon Sheat Rock		Westcott Cove, Cove Harbor, Moraton Neck, Roton Pt.		Sheffield Is., Stamford Park, Sherwood Is. State Park, Calf Pasture Beach, Roton Pt.		
6						Hart Tretten, Orchard Beach, Pelham Bay Park				Little Neck Bay, Eastchester Bay	Nassau & Bronx Counties (see text)		
7						Sunken Meadow State Park, Mt. Sinai Harbor, Target Rock Ref.			Smithtown Bay		Caumsett State Park, Sunken Meadow State Park		
8										Mattituck, Greenport	Wildwood State Park		
Environmental	Good	Good	Good	Good	Good	Good	Good	Good	Good	Fair	Fair	Good	Fair
Economic	Good	Good	Fair	Poor	Poor	Fair	Fair	Poor	Fair	Good	Fair	Good	Fair
Total Benefits (millions)	High	7.5	High	High	Medium	High	Medium	High	.3 to 1.2	.68 - .84	8	Medium	Medium
Total Costs (millions)	2	4	.05	.005/A	7	6	.5-4	Billions	?	.76 - 1.4	2	.002-.008	4
B/C	High	1.7	Medium	High	Medium	Medium	Medium	?	.5-1	.6-.4	.4	Medium	Medium
Social	Good	Fair	Good	Good	Poor	Good	Fair	Good	Good	Fair	Good	Good	Fair
Agency	States, NMFS	States	States	States, FWS	CE, NMFS	States, FWS Municipalities	FWS, States	States	States	States	States, Municipalities	States, NMFS	States, Municipalities

1 Numbers in parentheses refer to number of locations within the towns considered for increased flushing

2 Refer to recreational Planning Report for specific areas and costs for projects in Connecticut and for additional sites in New York

with other objectives, the NED Plan also includes those measures rated in Table 11 as "Fair" under NED and "Good" under either EQ or SW. On this basis then, the NED Plan is the same as the EQ Plan.

7.3 Composite Plan

The Composite Plan includes all the measures of the EQ and NED Plans except (1) assistance programs for the commercial fishermen and (2) establishment of more port landing facilities. These measures rated only "Fair" on an environmental, economic, and social basis.

7.4 Priorities

Priorities in this report indicate the relative importance of implementing the recommendations. First priority is generally given to measures promising (1) a reasonably high degree of environmental quality, (2) with a good to fair economic and/or social rating, and (3) with no poor EQ, NED, or SW rating. Other special considerations can override and are so indicated. In some instances, second priority is given to recommended specific projects of the alternative measures. All measures are intended to be implemented before 1990 unless otherwise stated in the tentative recommendations.

8.0 TENTATIVE RECOMMENDATIONS

Implement the Composite Plan as explained in Section 7.3.

First Priority Recommendations

Establish marine fishery management/research programs. In order to know the capability of specific fishery resources to be utilized over the long term without detrimental changes, both states should institute State-Federal management/research programs in conjunction with the National Marine Fisheries Service. These programs would include (1) establishment of a technical-management committee, possibly a task subcommittee of the Atlantic States Marine Fisheries Commission or the Northeast Marine Fisheries Council, (2) a new system of catch and effort statistics for resident commercial and recreational finfisheries and shellfisheries of the Sound, (3) a program of natural history studies and surveys on resident species and habitats to evaluate biological resources, and (4) development of joint statistical and management programs, through the Northeast Marine Fisheries Council, the Atlantic States Marine Fisheries Commission, and the International Commission for the Northwest Atlantic Fisheries, in conjunction with adjacent states which share migratory fishery resources.

Preserve/create/restore wetlands. This measure rated poorly under the NED objective, but since it is such an important factor in the maintenance of environmental quality, it is rated as a first priority measure. To insure maintenance of the natural biological productivity in the Sound, Connecticut and New York should enhance their wetlands management program by 1980 to include (1) no development within a maritime zone (about 300 feet landward of mean high water), (2) wetland rehabilitation and restoration, and (3) wetland creation using dredge spoils and marsh grass plantings.

Establish public environmental education programs. To impress upon Man his dependence and integral role within nature, public environmental education programs should be instituted in both states at local levels through the local school systems and through development of outdoor learning centers. Title III grants available through the Elementary and Secondary Education Act of 1965 could be used to support such programs.

To stress the value of wetlands, several nature centers could be established in carefully selected salt marsh areas along the Sound. Boardwalks through the wetlands and signs describing the ecological interactions of the marsh would be an educational tool in alerting the public to the importance of wetlands. It is recommended that Connecticut support development of nature centers at Sherwood Island, Hammonasset, East Shore, and Harkness Memorial State Parks, Great Meadow, and Shea Island, and New York should do the same at Mt. Sinai Harbor and Sunken Meadow State Park, Fort Totten, Orchard Beach, and Pelham Bay Park. The U. S. Fish and Wildlife Service should initiate a nature center program at the newly acquired Salt Meadow Refuge in Westbrook, Connecticut and the existing program at Target Rock Refuge, Oyster Bay, New York, should be expanded.

Establish additional upland wildlife management areas. To improve upland hunting and non-consumptive opportunities, Connecticut and New York, with federal assistance, should acquire upland areas for combination use as preserves and game management areas. Hunting would be on a permit basis. Birdwatching, nature hiking, and other "non-consumptive" activities would be on a small group basis. Both types of activities would, of course, be seasonal.

Acquire islands as wildlife management areas. Connecticut should acquire Chimon Island (in cooperation with the Town of Norwalk) using Land and Water Conservation funds for use as a nature preserve, and for wildlife research and guided wildlife tours. Shea Island which is owned by the Town of Norwalk should be managed as a wildlife area with limited use for research and environmental education.

Three eastern Sound islands (Dodge, Andrews, and Menunketesuck) should be acquired, with federal funds, for nature observation with some fishing, waterfowl hunting, and scuba diving. Barn and Great Island should be maintained as wildlife management areas with regulated public use for fishing and waterfowl hunting. It is further recommended that the states of Connecticut and New York should work with federal agencies to establish a natural areas preserve/wildlife refuge system consisting of representative examples of areas of critical

environmental concern identified by the states under the federal Coastal Zone Management Program. These areas include estuaries, islands, barrier beaches, tidal wetlands, bluffs, dunes, and areas of transition from salt marsh to upland vegetation. The preserve system would be established and managed in conjuction with academic institutions bordering the Sound, and viewed primarily as resources for educational and research uses. It is recommended, furthermore, that Connecticut's ongoing acquisition program for the smaller, less expensive islands in the Sound not only be continued, but accelerated, if possible. These smaller rock islands are of benefit to nesting gulls and terns.

Maintain or increase species diversity. To improve wildlife resources and increase consumptive and non-consumptive uses of these resources, it is recommended that Connecticut and New York, with federal assistance, adopt measures which will insure species diversity such as periodic cutting and thinning of woodland areas, maintenance of "green belts" in urban areas, and promotion of old-field succession in former agricultural sites. Establishment of a comprehensive fisheries management/research program would include consideration of species diversity.

Improve water quality. Water quality improvement also rated poorly under the NED objective, but since so many of the recommendations hinge on this program, it is included as a first priority measure. To improve fish and shellfish habitat and to increase opportunities for recreational and commercial use of the Sound, it is recommended that water quality be improved for fishing and swimming and, in some cases, for shellfishing, particularly in the eastern Connecticut regions (Thames River and Connecticut River area). Connecticut and New York should work closely with the Environmental Protection Agency in improving water quality and in maintaining water quality in areas presently open for shellfishing since water quality standards and improvement fall under the jursidiction of EPA. In conjunction with this program, both states, with federal assistance, should develop research programs on the reliability of shellfish purity indicator organisms other than coliform bacteria and should continue to monitor the effects of pesticide pollution on the Sound's ecosystem.

Improve fishery habitat. To improve fishery habitat, artificial reefs should be constructed under State and municipal authorities. Although further investigations and evaluation of specific sites for the establishment of these reefs is needed, the following possible locations are suggested: Connecticut -- New Haven Harbor, Bridgeport Harbor, Westcott Cove, Cove Harbor, Noroton Neck, and Roton Point; New York -- Smithtown Bay. In sandy areas, where flatfish are normally caught, it is conceivable that the diversity of the catch (to include tautog, sea bass, scup, etc.) could be increased by constructing small artificial reefs in close proximity to the piers (Figure 7).

Improve access for fishing. It is recommended that general public access to the shore and navigable waters should be available and guaranteed by statute without social and municipal constraints. Also, small boat rental facilities and launching ramps should be increased at Little Neck Bay

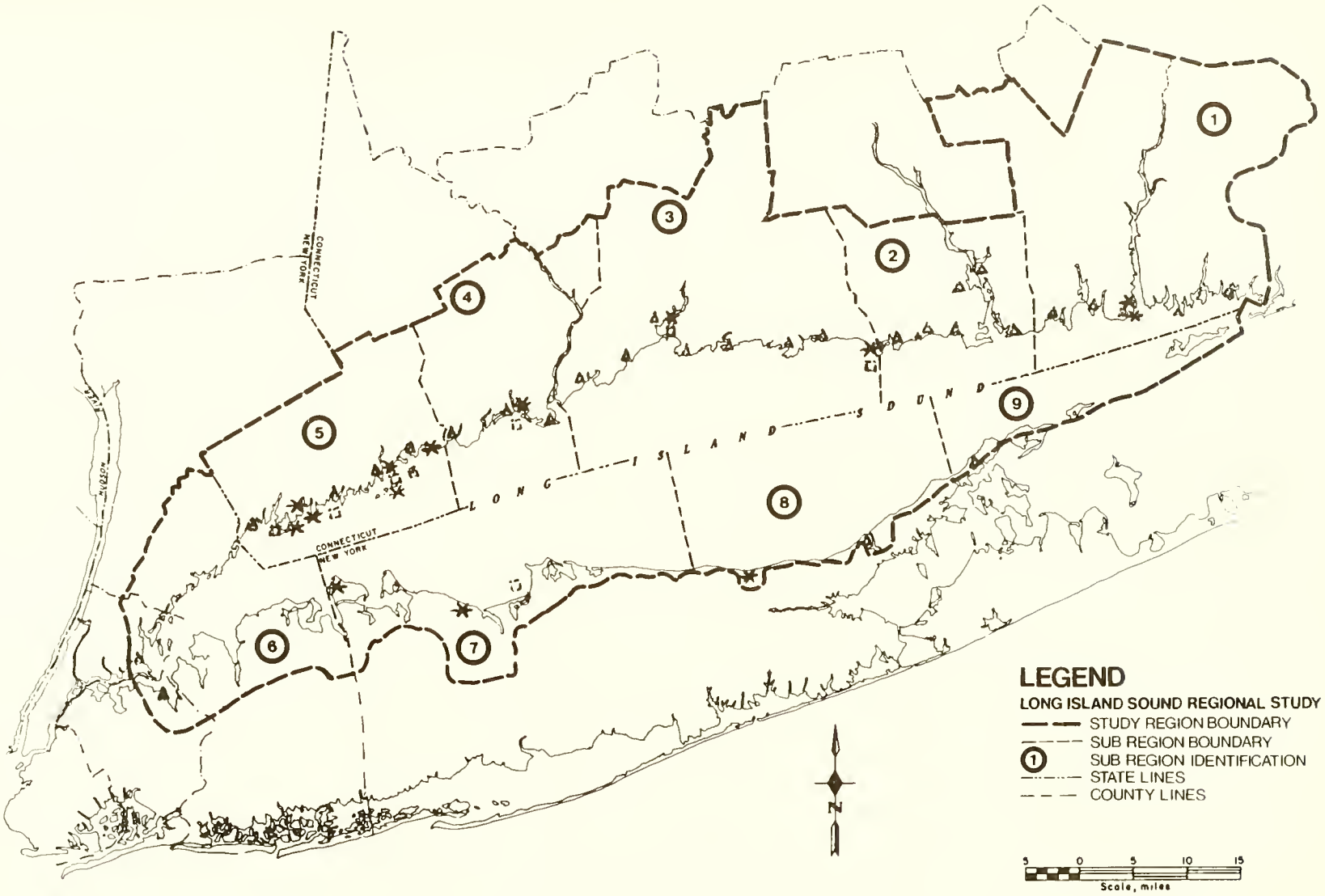


Figure 7. General locations for proposed access points, fishing piers, and artificial reefs in Long Island Sound.

and Eastchester Bay and charter and/or party boat facilities should be increased at Greenport and Mattituck, New York if parking and transportation facilities can be expanded. At the present time, Connecticut's general policy concerning boating access is to have at least one public boating access point for each town bordering the Sound. Therefore, it is recommended that approximately 25 additional access points be purchased in these coastal towns when and if property becomes available. Public access to the shoreline should also be encouraged at the ends of streets and roads abutting the Sound and its tributaries. Both states should sponsor legislation funding public access for fishing, particularly where federal funds have been used for construction of sea walls, jetties, and groins. Public utilities should be encouraged to open jetties and sea walls for fishing as part of their public relations and community service role.

Improve availability of fishing grounds. Bottom restoration, development of new beds, better aquaculture techniques, and improved hatchery methods are recommended to enhance opportunities for shellfishing. Construction of fishing piers and maintenance of present piers will provide additional sport fishing opportunities for the urban dweller, children, and low income groups. It should be understood that further study and evaluation of specific sites for the construction of fishing piers is needed. In the case of Nassau and Bronx Counties, where access is extremely limited, it is recommended that access acquisition be considered a future project to be implemented when and if land becomes available. Some possible sites for acquisition in these counties include areas of the Throgs Neck Bridge, City Island, Harbor Island and Mamaroneck Harbor. However, at the present time, it is recommended that states and/or municipalities construct fishing piers, where feasible, at Harkness Memorial Park, Ocean Beach, Hammonasset State Park, Stamford Park, Bridgeport Harbor, Sherwood Island State Park, Sheffield Island, Calf Pasture Beach, Sunken Meadow State Park, Wildwood State Park, and other suitable areas in New York and Connecticut.

Promote underutilized species. States, together with NMFS and public environmental education programs, should encourage the use and promotion of underutilized finfish and shellfish species (skate, cunner, dogfish, conch, sea robin, mussels). Provided the recreational fisherman can identify these species and is aware of the ways to prepare these fish for the table, the use of these species should provide increased recreational fishing satisfaction and may increase localized market products.

Second Priority Recommendations

Increasing tidal flushing is a specific project under the recommendation to improve and restore wetlands; however, since tidal flushing rates poor economically and socially, it has been rated as a secondary recommendation. To help restore natural salt marsh productivity, the federal government (Fish and Wildlife Service, NOAA) and States should increase tidal

flushing in carefully selected areas via conscious neglect of tidal gates and impoundments, increased road culvert size, and improved methods of mosquito control.

Conditional Recommendations

Establish uniform size and bag limits. Establishment of uniform size and bag limits on finfish and molluscan shellfish is a conditional recommendation dependent on research findings regarding whether or not the resource in the Sound is being overutilized. Should results prove that the population levels of various fish in the Sound are at dangerous levels, Connecticut and New York should institute uniform size limits for these species based on valid scientific information and should establish uniform bag limits based on data collected in creel censuses. The recommendations of the Lobster Scientific Committee, under the auspices of the Northeast Marine Fisheries Council, should be evaluated by New York and Connecticut. If these recommendations are found to be biologically justifiable, they should be accepted.

9.0 ADJUSTMENTS

Presently, the recommendation for salt-water fishing licenses meets with extensive public opposition in New York and Connecticut. Until such a time when the general public is better aware of the benefits which could be derived from this project, and until it is assured that revenues derived from salt-water licenses will be specifically ear-marked for marine management and research, it is suggested that establishment of a salt-water fishing license be considered a revenue-raising program that could be implemented in the future.

10.0 FINAL RECOMMENDATIONS

1) Establish marine fishery management/research programs

2) Preserve/create/restore wetlands

3) Establish public environmental education programs

4) Establish additional wildlife management areas

5) Acquire islands as wildlife management areas

6) Maintain or increase species diversity

7) Improve water quality

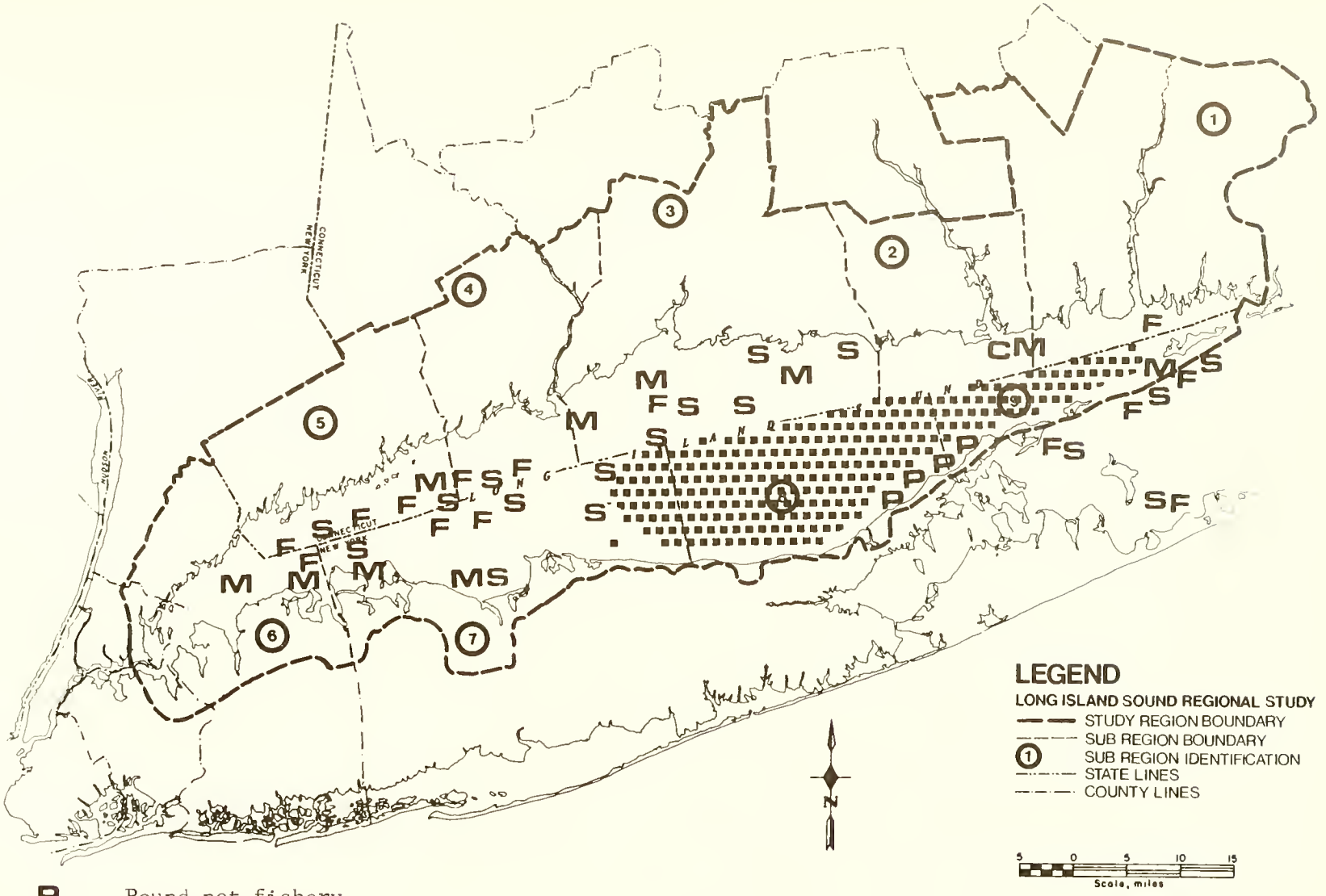
(8) Improve fishery habitat

(9) Improve access for fishing

(10) Improve availability of fishing grounds

(11) Promote underutilized species

The preceeding recommendations have not necessarily been approved by the New England River Basins Commission. At the time of this report's publication, the draft main report of the Long Island Sound Regional Study is undergoing public review and comment for consideration in the final document. The FINAL RECOMMENDATIONS on Fish and Wildlife are therefore to be found only in the final version of the Study's main report--to be published in the Spring of 1975.



P Pound net fishery

Otter trawl fishery

S Scup fishery

F Flounder fishery

C Connecticut River shad and alewife fishery resource

M Menhaden fishery

Plate 1. Descriptive and historical commercial finfisheries of LIS.

APPENDIX A

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APPENDIX B

GLOSSARY

Acute Toxicity - Any poisonous effect produced within a short period of time, usually up to 24-96 hours, resulting in severe biological harm and often death.

Anadromous - Refers to fishes, such as striped bass and shad, which spend most of their life cycle at sea but return to rivers and streams to spawn.

Benthic/Benthos - The plant and animal life whose habitat is the bottom of a sea, lake or river and may be found on or in the substrata.

Biological Magnification - The buildup and inability to discharge any substance found in consumed prey resulting in an increase of that substance at higher levels of a food web.

Biomass - The total particulate organic matter present, usually given on a per unit area or volume basis, such as biomass of plankton in grams per cubic meter of ocean, or eelgrass in grams per square meter of bottom.

Catadromous - Refers to fishes, such as the eel, which mature in fresh water and migrate to the sea to spawn.

Chlorinated Hydrocarbons - A class of generally long-lasting, broad spectrum insecticides of which the best known is DDT.

Chronic Toxicity - Marked by and causing long duration or frequent recurrence of unhealthy organisms.

Detritus - Finely divided settleable material of organic or inorganic origin which is suspended in the water or settled on the bottom but is not consolidated.

Ecosystem - An ecological system, formed by the interaction of coacting organisms and their environment.

Entrained - The suspension and/or movement of organisms and sediments by flowing water. Usually used in reference to intake or discharge systems.

Estuary - A semi-enclosed coastal water body which has free access to the sea, the water being measurably diluted with fresh water derived from land drainage.

Euryhaline - Organisms which can accomodate wide salinity variations.

Eutrophication - A condition where nutrients, especially nitrogen and phosphorous compounds, are excessively available allowing algae and other microscopic plant life to become superabundant, often resulting in the decline of more valuable organisms and high primary productivity coupled with lowered species diversity.

Food Web - A sequence of organisms, each of which provides food for the next in the chain; generally involves complex interrelationships among the organisms of an ecosystem.

Habitat - The sum total of environmental conditions of a specific place that is occupied by an organism, a population or a community.

Oyster Setting - That period in the life-cycle of oysters when they change from swimming forms to attached, shelled oysters on the bottom.

Pelagic - Organisms which inhabit the water column as opposed to benthic species which live on the bottom, or littoral species which live near the intertidal zone.

Phytoplankton - The plant organisms which drift passively or swim weakly in the aquatic realm, and are generally distributed by local tides and currents.

Raft Culture - The use of rafts to grow shellfish off the bottom and thus away from bottom crawling predators; production may be improved by this method.

River Basin - The total area drained by a river and its tributaries.

Stenohaline - Organisms which tolerate only a narrow range of salinity variations.

Synergistic/Synergism - The cooperative action of separate substances, the total effect being greater than the sum of the effects of the substances acting independently.

Trophic Level - The position which an organism occupies in a food chain or food web, such as primary producer, herbivore or carnivore.

Zooplankton - The animal organisms which drift passively or swim weakly in the aquatic realm, being generally at the mercy of tides and currents but able to rise and settle.

APPENDIX C
EVALUATION MATRIX - FISH AND WILDLIFE

CRITERIA	Measures to Sustain the Natural Biological Productivity of the Sound Area											Measures to Increase Economic Value and Public Enjoyment of the Sound					
	Establish fishery mgmt./ research programs	Establish salt-water license program	Use of non-rebated gasoline taxes	Preserve/ create/ restore wetlands	Increase tidal flushing	Establish public educational programs	Estab. add. wild. mgmt. areas	Acquire islands	Maintain species diversity	Improve water quality	Improve fishery habitat (artificial reefs)	Estab. uniform size & bag limits	Improve access for fishing	Estab. fishing piers	Promote under-utilized species	Estab. port landing facilities	Assistance programs for commercial fishermen
1. ENVIRONMENTAL CRITERIA																	
a. Environmental quality																	
(1) Natural beauty	o	o	o	++	++	+	+	++	+	++	++	o	o	o	o	o	o
(2) Land erosion & sediment	-	o	o	+	-	+	+	o	o	+-	++	o	-	-	o	o	o
(3) Water & water quality	+	o	+	++	++	++	+	+	o	++	++	o	o	o	o	-	o
(4) Air & air quality	o	o	o	+	+	+	+	+	o	-	++	o	o	o	o	-	o
b. Ecological systems[1]																	
(1) Terrestrial																	
(a) Plants	o	o	o	o	o	++	++	++	++	o	o	o	o	o	o	o	o
(b) Animals	o	o	o	+	o	++	++	++	++	o	o	o	o	o	o	o	o
(2) Aquatic																	
(a) Plants	o	o	++	++	++	++	o	++	o	++	++	o	o	o	o	o	+
(b) Animals																	
1. Anadromous	++	+	+	++	++	++	o	++	o	++	++	++	o	o	+	o	+
2. Resident	++	+	++	++	++	++	o	++	o	++	++	++	o	o	+	o	+
c. Scarce resources																	
(1) Archeological-historical	o	o	o	o	o	+	o	o	o	o	o	o	o	o	o	o	o
(2) Biological[2]	++	+	+	++	++	++	++	++	++	++	++	++	o	o	++	o	+
(3) Geological	o	o	o	o	o	+	o	o	o	o	o	o	o	o	o	o	o
d. Irreversible commitments	o	o	o	o	o	o	o	o	o	o	o	o	-	o	o	o	o
e. Summary environmental rating	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Fair	Fair	Good	Fair	Fair
2. ECONOMIC CRITERIA																	
a. Benefits (total) (millions)	High	7.5	High	High	Medium	High	High	Medium	High	High	.36 - 1.2	Medium	.48 - .64	0.8	Medium	Medium	Medium
b. Costs (total) (millions)	2.0	2.0	.05	.005 /A	Medium	6.0	Medium	0.5 - 4.0	Low	Billions	0.7	Low	.76 - 1.4	2.0	.002 - .008	4.0	Medium
c. B/C ratio	High	3.5	Medium	High	Medium	Medium	Medium	Medium	Medium	?	.5 - 1.7	Medium	.6 - .4	.4	Medium	Medium	Medium
d. Other																	
(1) Jobs (+ is more jobs)	+	o	o	o	o	+	o	o	o	+	o	o	o	+	+	+	+
(2) Population (+ is concentrated)	o	o	o	+	+	+	+	o	+	+	o	o	o	o	o	o	o
(3) Economic base & stability	++	+	++	+	o	++	+	o	+	+	++	+	+	+	+	+	o
(4) Environmental desirability	++	+	+	++	++	++	++	++	++	++	++	+	+	+	o	o	o
e. Summary economic rating	Good	Good	Fair	Poor	Poor	Fair	Good	Fair	Good	Poor	Fair	Good	Good	Fair	Good	Fair	Fair
3. SOCIAL CRITERIA																	
a. Real income distribution																	
(1) Primary incidence of benefits	Public	Public	Public	Public	Public	Public	Public	Public	Public	Public	Public	Public	Public	Public	Public	Public	Private
(2) Primary incidence of costs	Public	Public	Public	Public	Public	Public	Public	Public	Public	Public	Public	Public	Public	Public	Public	Private	Public
b. Life, health, safety	o	o	o	+	-	+	o	o	o	++	+	o	o	o	+	o	o
c. Educational, cultural, recreational	+	+	++	++	+	++	++	++	++	++	++	+	+	++	++	o	o
d. Ability to meet other needs[3]																	
(1) Land use	o	o	o	+	-	+	+	+	+	+	o	o	o	o	o	o	o
(2) Water quality	o	o	+	+	+	+	+	+	+	++	++	o	o	o	o	o	o
(3) Water supply	o	o	o	o	o	+	o	o	o	o	o	o	o	o	o	o	o
(4) Shoreline appearance & design	o	o	o	++	+	+	o	++	o	++	o	o	o	o	o	o	o
(5) Erosion & sedimentation	o	o	-	+	-	o	+	o	+	o	-	o	o	o	o	o	o
(6) Flood damage reduction	o	o	-	++	=	-	o	+	+	o	-	o	o	o	o	o	o
(7) Recreation	+	+	++	+	+	++	++	-	++	++	++	+	++	++	++	o	o
(8) Fish & wildlife	++	+	++	++	++	++	++	++	++	++	++	+	+	+	+	+	+
(9) Transportation	o	-	o	-	-	-	o	-	o	-	-	o	-	o	-	-	o
(10) Minerals	o	-	o	-	o	-	o	o	o	-	-	o	o	o	o	o	o
(11) Power	o	o	-	-	o	-	o	-	o	-	-	o	o	o	o	o	o
e. Legal-judicial involvement[4]	o	=	=	o	=	o	o	=	o	o	-	o	-	o	o	o	=
f. Institutional	States, NOAA, FWS	States	States	States, FWS	States, NOAA, FWS	Towns, States, FWS	States, FWS	States, FWS	States, FWS	States	States	States, NOAA	States	States	States, NOAA	States	States, FWS
(1) Agencies responsible	=	+	-	=	-	=	o	=	=	=	o	=	o	o	o	o	-
(2) Ease of administering																	
(3) Preferability of non-federal action[5]	o	o	-	-	o	=	o	=	-	-		-	o	o	o	o	o
g. Political																	
(1) Ease of creating institution	o	o	-	-	o	-	-	-	-	-		-	o	o	o	o	o
(2) Ease of passing law	o	=	-	-	-	-	-	=	-	=		-	o	o	o	o	o
h. Other																	
(1) Community continuity	-	-	+	o	-	++	+	o	o	+	-	-	+	+	+	-	o
(2 Environmental attractiveness	+	o	+	++	+	++	++	+	++	++	++	-	+	o	o	o	o
(3) Years to implement	5-10	10-20	0-5	0-5	0-5	0-5	0-5	0-5	0-3	>10	0-5	0-5	5-10	0-5	0-5	5-10	0-5
i. Summary social rating	Good	Fair	Good	Good	Poor	Good	Pref. EQ	Fair	Good	Only EQ	Good	Fair	Fair	Only SW	Good	Fair	Fair
4. APPLICABILITY TO GENERAL OBJECTIVES[6]	Pref. EQ	Pref. EQ	Pref. EQ	Only EQ	Only EQ	Pref. EQ		Only EQ	Pref. EQ		Pref. EQ	Pref. EQ	Pref. EQ		Only SW	Pref. NED	Pref. NED

APPENDIX C

DETAILED EVALUATION OF ALTERNATIVE MEASURES

Entries in the matrix

Unless otherwise indicated, entries in the evaluation matrix reflect judgments as to the most likely, overall, long-term, and widespread effects of implementing a specified measure (a column) on a specified criterion (a row) -- as perceived from the egocentric view of the criterion. Most entries in the matrix are portrayed by the following symbols:

+	beneficial	-	adverse
++	highly beneficial	=	highly adverse
		o	not applicable, or benefits and adversities are generally minor

FOOTNOTES

1. Benefits to an ecological system reflect broad judgments as to the most likely, overall, long-term, and widespread effects on the system under consideration.

2. Biological benefits here are increased opportunities to observe rare and endangered species and the ecological systems upon which they depend with the end of significantly enlarging understanding and appreciation of the natural world as the habitat of man. All programs that would involve any significant construction, inundation or change in land use patterns are rated highly adverse. This rating is based upon the general expectation that given enough study, almost every area of any size will be discovered to have one or more scarce biological species, or be able to be described as a unique locale for studying one or more such species.

3. Listed here are the subjects addressed in the 10 LISS planning reports; one has been subdivided into water quality and water supply. An entry reflects a judgment as to whether the net effects of an alternative program will complement (+) or conflict (-) with the listed planning report.

4. A "o" rating reflects the judgment that implementation of the program will require insignificant judicial involvement. A " = " indicates severe judicial problems.

5. If federal action is recommended and non-federal action is more likely and more effective, a " = " is entered. Otherwise the entry is "o".

6. Hardly any project or program can be classified as completely oriented toward EQ or toward NED. Furthermore, almost every alternative can be adapted to minimize its adverse effects on an apparently incompatible objective. For the purpose of subsequent plan formulation, however, some meaningful categorization is very desirable here. Five entries were used to reflect this categorization:

   Only EQ - important for EQ reasons, despite significant economic objections.

   Pref. EQ - preferable for EQ reasons, no significant economic objections or preferences.

   Pref. NED - preferable for NED reasons, no significant environmental objections or preferences.

   Only NED - important for NED reasons, despite significant environmental objections.

   Only SW - not particularly desirable or objectionable for environmental or economic reasons, preferable only for reasons of social well-being.

APPENDIX D

LOCATIONS, ACREAGES, PERCENT CLOSED, AND REASONS FOR SHELLFISH CLOSURES FOR NEW YORK (LONG ISLAND) AND CONNECTICUT.

Location	Total Acres	Open Acres	Closed Acres	% Closed Acres	Reason for Closure: Contamination Fecal	Contamination Petroleum
New York[+]						
Mattituck Inlet	125	100	25	20	x	
Mt. Sinai Harbor	455	455	--	--		
Pt. Jefferson Harbor	1,550	735	815	53	x	x
Stony Brook Harbor	855	855	--	--		
Nissequogue River	555	--	555	100	x	
Smithtown Bay	22,300	21,800	500	2	x	
Huntington Bay	2,420	2,420	--	--		
Northport Bay	1,825	1,825	--	--		
Northport Harbor	410	110	300	73	x	
Centerport Harbor	400	270	130	33	x	
Duck Island Harbor	185	185	--	--		
Lloyd Harbor	600	600	--	--		
Huntington Harbor	340	175	165	49	x	
Oyster Bay Harbor	5,040	4,665	375	7	x	x
Cold Spring Harbor	1,325	1,230	95	7	x	
Dosoris Pond	105	--	105	100	x	
Hempstead Harbor	3,465	--	3,465	100	x	x
Fishers Is. Sound	7,990	7,080	910	11	x	
Manhasset Bay	2,725	--	2,725	100	x	x
Westchester Shore	15,520	--	15,520	100	x	
Long Is. Sound	397,000	369,180	27,820	7	x	
TOTAL	464,190	411,685	53,505	12		
Connecticut[o]						
Greenwich	1,049	--	1,049	100	x	
Stamford	247	--	247	100	x	
Darien	320	280	40	12.5	x	
Norwalk	1,300	1,300	--	--	x	
(Norwalk)[++]	2,066	918	1,148	56	x	
Westport	4,778	4,778	--	--	x	
(Westport)[++]	2,301	1,912	389	17	x	
Fairfield	259	163	96	37	x	
Bridgeport	2,575	2,407	168	7	x	
Stratford	3,078	1,150	1,928	63	x	
Milford	5,000	4,600	400	8	x	
West Haven	3,000	1,800	1,200	40	x	
(West Haven)[++]	1,000	--	1,000	100	x	
New Haven	2,645	--	2,645	100	x	
TOTAL	29,618	19,308	10,310	35		

[+]Personal communication, Bruce MacMillan, NYSDEC, Stony Brook, NY.

[o]Represents leased areas only.

[++]Indicates town shellfish grounds.

APPENDIX E - COMMENTS

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northeast Region
Federal Building - 14 Elm Street
Gloucester, Massachusetts 01930

January 16, 1975

Mr. Ronald Sake
Fish and Wildlife Service
U.S. Department of the Interior
50 Maple Avenue
Patchogue, New York 11772

Dear Mr. Sake:

The final draft Fish and Wildlife Planning Report has been reviewed as requested by Mr. David Burack, Study Manager, Long Island Sound Study, by memorandum dated December 31, 1974. According to Mr. Burack, this is our last opportunity to make comments relative to the specific planning report in question. While the report appears to be general enough and free of substantial controversial issues, there are several areas which deserve to be brought to your attention. Whether or not they are of sufficient substance to warrant changes at this state of Planning Report development, we will leave to your judgment as Work Group Chairman.

The Fishery, page iii:

This paragraph could be made more definite in light of information contained therein. The question is raised regarding the comparison of sport fishing and commercial fishing on an economic basis. Certainly, if the numbers of fishermen listed are reasonably accurate, then the sport fishery is at least three-to-four times more valuable if we assume only one dollar per day is generated by each sport fisherman. Clearly, one dollar per day is highly conservative. It is in this context, then, that the paragraph can definitely state that sport fishing, at present, generates more income to the region.

Page 40, second full paragraph:

The last sentence is awkward and should be rewritten for clarity, indicating tidal gates serve, at present, to protect homes from extremely high tides which are presumably storm-induced.

10.0 Final Recommendations, page 55:

Item 8 (Improve fishery habitat) includes creation of artificial reefs, as explained elsewhere in the report and actually specified in Figure 7,

page 52. With regard to this recommendation we caution you to consider carefully the potential problems if reefs are not constructed with care and of specific materials. Further, they would be most beneficial in areas of low productivity or where existing fishing by recreationists is less than adequate. Reef formation is not yet a fully accepted practice and increased catches of fishes lately reported in the literature remain only of general value until the true relationship of reefs to production is fully understood.

Sincerely,

Russell T. Norris
Regional Director

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

JAN 22 1975

Mr. Ronald Sake
Fish and Wildlife Service
50 Maple Avenue
Patchogue, New York 11772

Dear Mr. Sake:

This is in reply to Dave Burack's letter of December 31, 1974 requesting comments on the "Fish and Wildlife" planning report. We have reviewed the report and have the following minor comments.

1. p. iii The main reason for the decline in commercial catch in LIS is not clear (for example, whether a result of general decline in LIS desirable fish population or of inability of LIS fishermen to compete because of equipment limitations or of public preference for species best obtainable elsewhere, see p. 10). Although the general tone of the report seems to be that the decline in commercial catch is an undesirable economic fact, the eventual recommendations do not appear to include assistance actions directly related to improving this commerce (despite the [illegible] on p. 46). The desirability of general improvement in water quality and productivity and accessibility of testing grounds (see p. 44) and consequent increases in non-commercial fishing may in effect form more competition for commercial fishing. It is not clear whether such considerations have been taken into account and balanced in the report's final recommendations.

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2. p. 5 fifth last line "Arcatia" should read "Acartia".

3. p. 32 Item 4.2 asks the title question of "What is the capacity of the region's wildlife resources to satisfy demand?" but the ensueing discussion does not really answer this. The text instead provides only general statements of the existing types of wildlife without any adequate projection of trends in the various populations (as functions of loss of habitat, pressure of increased future hunting and fishing, etc.). Neither is this question adequately related to the question on p. 25 which deals in a very general way with possible major limits on productivity, but indicates no quantitative limits.

I hope these brief comments prove useful to you.

Sincerely,

Walter G. Belter
Analysis and Assessment Programs
Division of Biomedical and
Environmental Research

cc: D. Burack, LISS

COORDINATING GROUP
LONG ISLAND SOUND REGIONAL STUDY
As of the date of this report

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State of Connecticut	Richard Dowd
Conn. Coastal Zone Management Committee	Senator George L. Gunther
Connecticut Department of Finance and Control	Horace Brown
State of New York	John A. Finck
Interstate Sanitation Commission	Thomas R. Glenn
Tri-State Regional Planning Commission	Richard DeTurk
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Research/Planning Advisory Committee	Lawrence E. Hinkle, Jr. M.D.
Study Manager	**David A. Burack

*Chairman **Executive Secretary

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State of Connecticut	Robert Jones
State of Connecticut	George Maltezos
Citizens Advisory Committee	George Vanderborgh
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*Chairperson **Acting Cochairperson

Primary responsibility for these planning reports rests with the chair agency indicated above. The other agencies and individuals listed participated either in an active, a review, or an advisory role, but their listing here does not necessarily imply an endorsement of the report in whole or in part.